The Engineer

LONDON, FRIDAY, AUGUST 14, 1942.

PUBLIC NOTICES

UNIVERSITY OF MANCHESTER

PHYSICS DEPARTMENT

Full Particulars of the LECTURES and LABORATORY CLASSES in PHYSICS, preparing for both the Ordinary and Honours Degrees, will be forwarded on application to the REGISTRAR. The SESSION COMMENCES on Thursday, OCTOBER 1st. 8672

DORSET COUNTY COUNCIL EDUCATION COMMITTEE

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A. F. ALEXANDER,
Acting County Education Officer.

Education Department,
Shire Hall,
Colliton Park,
Dorchester,
Dorset. 8677

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The Engineer

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CORRESPONDENCE *re* Accounts and Remittances should be sent in future to:

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CLASSIFIED ADVERTISEMENTS CLOSE FOR
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The Engineer

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

Postal Address,
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PATENTS

IT is DESIRED to SECURE the Full COMMERCIAL DEVELOPMENT in the United Kingdom of BRITISH PATENT No. 432,653, which relates to "Improvements in Priming Means for Internal Combustion Engines," either by way of the GRANT of LICENCES or otherwise on terms acceptable to the patentees.—Interested parties desiring a copy of the specification and further particulars should apply to PHILLIPS and LEIGH, Chancery Lane Station Chambers, 31/33, High Holborn, London, W.C.1. 8688 H

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For continuation of Small Advertisements see page 58.

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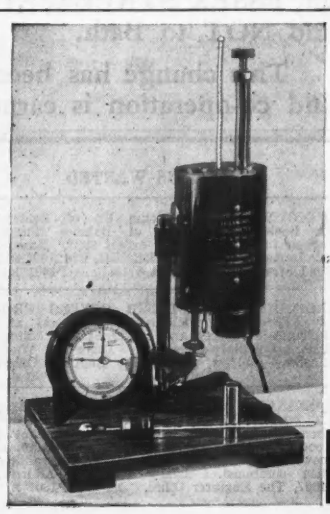

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A Seven-Day Journal

The Late Mr. C. A. Carus-Wilson

THERE are many engineers in this country and in Canada who will learn with particular regret of the death of Mr. Charles Ashley Carus-Wilson, which took place at Bournemouth on Friday, August 7th. Mr. Carus-Wilson, who was the son of the late Rev. W. Carus-Wilson, was born in 1860 and received his education at Haileybury, at Pembroke College, Cambridge, and at the Royal Engineering College, Coopers Hill. In 1882—when he was twenty-two—he was sent out to Bucharest to install electric light in the King of Roumania's palace. In 1887 he returned to Coopers Hill College to take up an appointment on the staff, and in 1890 he became Professor of Electrical Engineering at McGill University, Montreal. He held this appointment until 1898, and after returning from Canada practised as a consulting engineer in Westminster. During the last war he served on the staff of the Royal Naval College, Osborne. Mr. Carus-Wilson was well known as a lecturer on various engineering and scientific subjects at the University College, London, and read many papers before the Institutions of Civil, Mechanical, and Electrical Engineers, as well as the Royal Society, the Royal Society of Arts, and the Physical Society.

Employment Returns

THE Ministry of Labour and National Service announced, on Friday, August 7th, that the number of men and boys registered at Employment Exchanges in Great Britain as wholly unemployed at July 13th, 1942 (exclusive of men, numbering 24,071, who had been classified by interviewing panels as unsuitable for ordinary industrial employment), was 66,116; those registered as on short time or otherwise temporarily suspended from work on the understanding that they were shortly to return to their former employment numbered 1728; and those registered as unemployed casual workers (being persons who normally seek their livelihood by jobs of short duration) numbered 2180. As compared with June 15th, the numbers wholly unemployed showed an increase of 3350, those temporarily suspended from work a decrease of 133, and unemployed casual workers a decrease of 822. The corresponding figures for women and girls at July 13th, 1942, were 35,320 wholly unemployed (exclusive of those, numbering 1238, who had been classified by interviewing panels as unsuitable for normal full-time employment), 1536 temporarily stopped, and 125 unemployed casual workers. Of the 35,320 wholly unemployed, 1269 had been classified as unable for good cause to transfer to another area. As compared with June 15th, the numbers wholly unemployed showed a decrease of 1154, those temporarily stopped a decrease of 273, and unemployed casual workers a decrease of 133. It may be noted that the increases in the numbers of boys and girls recorded as unemployed were largely due to the registration of school-leavers, in certain areas, at the end of the summer term.

An American Steel Mission

THE Combined Production and Resources Board announced on Monday, August 10th, that it had appointed an American Steel Mission to Great Britain for the purpose of studying, on a united basis, steel production problems of the two countries. The Mission will examine British production methods and requirements and will investigate means of increasing the quantity of steel needed for the United Nations' war effort. It is hoped that a British Steel Mission will visit the United States to make a similar study there when the American group returns home. The appointment of the Mission and arrangements for its visit to this country were completed one week after the Combined Production and Resources Board had held its first formal meeting. The chief items in the Mission's programme are:—Ways to increase total production of steel in the United States and Great Britain; the British system for the control of steel production, allocation, and distribution; how the two nations' steel can be brought into better balance so that plates, sheets, structural steel, &c., may all be produced in the proper ratio; whether increased production and saving of shipping space can be effected by sending more ingot steel and less finished weapons to Great Britain and *vice versâ*; what steel products can best be made in each of the two countries; which theatres of war should be supplied from Great Britain and which from the United States in order to save shipping space; the methods employed in this country for the collection and utilisation of steel scrap; British progress in reducing steel consumption by substitution, simplifying specifications and eliminating wasteful machine operations, and the means for pooling such information by both countries; what percentage of British steel production is used for war production and what percentage is essential for civilian production; and the means for obtaining economy in the use of scarce alloy steels.

Opening of Waterloo Bridge

SHORTLY after ten o'clock last Tuesday morning, August 11th, the first vehicle to pass over the new Waterloo bridge was diverted on to it from the southern end and some minutes later southbound traffic, too, was flowing over the bridge. As recently as July 17th we published an illustrated description of the bridge, work upon which was begun nearly five years ago. Had it not been for the war, it is probable that the bridge would have been fully open to traffic in 1940. At present it is to carry only two lines of traffic until such time as work on the northern end, at present impeded by the encroachment upon it of the temporary bridge, can be brought to completion. Thereafter the full width, sufficient for six lines of traffic, will become available. Though the bridge is substantially completed, certain work on it will be postponed until the war is over. The railings along the bridge are temporary and will eventually be replaced when lighting standards will also be added. Of four staircases, one on each side of the bridge on each side of the river, the construction of one on each side of the river will be left over for later completion. Work that will be completed in the ensuing few months includes the cleaning down of the Portland stone facing of the bridge and the removal of the contractors' gantry, a job requiring the extraction of over 1000 piles driven in the river bed.

R.A.F. Damage in the Ruhr District

ON Monday last the Bomber Command published further evidence of the extensive damage done in recent raids on the Western Ruhr, where the towns of Duisburg, Ruhrort Meidrich, and Hamborn form an important industrial area. Recent photographs show serious damage to the Thyssen steel works at Hamborn. In a recent attack a direct hit with a heavy bomb was made in the centre of the heavy rolling mills, which damaged 150,000 square feet of roof, besides doing other extensive structural damage. The sheet mill was also hit and 62,500 square feet of roofing stripped off and much of the supporting structure damaged. The power-house was also hit. The steel strip rolling mills and the finishing mill, which was damaged last March, were shown to be still under repair. Five other steel works in the Hamborn-Duisburg-Ruhrort area have also been damaged. A direct hit on a colliery in the Neuenkemp district destroyed much of the pithead gear and the surrounding buildings, while a zinc extraction works, a tar distillery, boiler works, and chemical factories show serious damage. The same photographs show damage near the port of Ruhrort, while at Oberhausen industrial buildings were destroyed. At Duisburg the main railway station, boiler-houses, a tar works, and a rolling mill were all damaged. At Düsseldorf further damage has been revealed as a result of the raid of the night of July 31st. Besides damage to the Krieger steel plant and the Schiess Aktiengesellschaft machine tool works, damage is shown at the August Schmitz Walzmaschinenfabrik and two works of the Deutsche Rohrenwerke, besides damage to the Woeste Maschinenfabrik, where the main shop was burnt out. Two buildings in the Heinrich Koppers silica works were damaged, and an extensive fire took place in the works, it is believed, of the Olex Petroleum Company. At Neuss a petroleum receiving depôt was destroyed.

A Ministry of Production Appointment

ON Tuesday, August 11th, it was announced from No. 10, Downing Street that the King had approved the appointment of Mr. George Morgan Garro-Jones, as the Parliamentary Secretary of the Ministry of Production. This appointment is a new one and it is expected that Mr. Garro-Jones will be able to give much assistance to Mr. Oliver Lyttelton, the Minister of Production, in connection with his parliamentary work. The work of the new Ministry is developing rapidly, and, in addition to his numerous administrative duties, the Minister has been obliged to be continually present in the House of Commons to take part in the various discussions and to give answers to the increasing number of questions which are being addressed to the Ministry of Production. In the future Mr. Garro-Jones will be able to assist Mr. Lyttelton with much of this particular work. For some time past it has been apparent that the work of the Minister as head of a new and growing department has, in addition to his duties as a member of the War Cabinet, imposed on him a heavy burden. Mr. Garro-Jones, who by profession is a barrister and journalist, represented South Hackney as a Liberal from 1924 to 1929. In 1935 he was returned as a Labour member for North Aberdeen, and has since been elected to the Executive of the Parliamentary Labour Party.

The Capacity of Royal Ordnance Factories

DURING the recent discussion in the House of Commons on the Royal Ordnance Factories, which is referred to elsewhere in this issue, Mr. Ralph Assheton, the Joint Parliamentary Secretary to the Ministry of Supply, dealt with the question of surplus capacity. Giving illustrations as to how such surplus might arise, Mr. Assheton pointed out that the new 4000-lb. bombs which were now being filled for the Royal Air Force were being used in place of smaller bombs which we were previously dropping. A certain amount of capacity for making the smaller bombs was therefore for the time being not being used, simply because the capacity which was suited for the building and filling of the smaller bombs was not suited for the bigger bombs. Another example of excess capacity, Mr. Assheton went on to say, arose owing to the fact that we had not used some of our gun barrels as much as we had expected, and owing also to the fact that since the war began technical improvements had been such that the life of some of these gun barrels had been found to be three times as great as before. There was undoubtedly some surplus in this direction, which no one could in any circumstances have foreseen. These were, he said, illustrations of what was constantly happening, and would continue to happen until the end of the war. Broadly speaking, the Ministry was very glad to have this surplus capacity. In the matter of absenteeism in the Ordnance Factories, Mr. Assheton stated that, taking the whole range of the twenty-three Royal Ordnance Factories, the figures for casual absence in the last six months had been reduced in the case of men from 4·6 to 2·5 per cent., and in the case of women from 10·5 to 5·2 per cent. In the explosive factories the casual absence of men has been reduced in six months from 6·4 to 3·1, and that for women from 19·5 to 10·8 per cent.

Salvage of U.S.S. "Lafayette"

THE United States Navy, agreeably to a decision made public on May 21st of the current year, is now actively undertaking the righting and refloating of the U.S.S. "Lafayette," formerly the French Transatlantic liner "Normandie." In an accompanying Supplement we reproduce some official U.S. Navy photographs of the vessel.

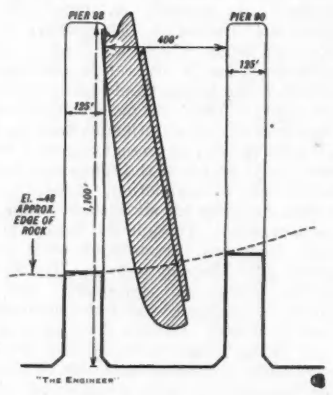
As will be recalled, the U.S.S. "Lafayette" was undergoing conversion for wartime service, and that work was nearing completion where she lay at Pier 88 on the North River water front of New York City, when a devastating fire developed aboard her in mid-afternoon of February 9th last. The eight fire-boats and the land fire-fighting apparatus mustered to her aid pumped water into the ship for about four hours before the conflagration was under control. The weight of that water caused the craft to list sharply to port, despite corrective efforts made to check that movement; and at 2.35 a.m., February 10th, the liner heeled over and came to rest on the bottom of the slip, with the bases of her smokestacks, at her topmost deck, just clear of the surface of the water. The "Lafayette" settled with her stern in contact with the outer end of Pier 88 and with her body in a diagonal position in the slip, her bow being about 100ft. from the bulkhead line and approximately in the centre of the slip, which is 400ft. wide.

The better to understand the task of dealing with the sunken vessel, one should know some of the physical conditions at the slip between Piers 88 and 90. Pier 88 was made ready for the liner just before she reached the port of New York early in June of 1935, on her maiden westward run. The pier is at the foot of West 48th Street, and is one of a group of piers built especially to berth ocean steamers having a length of 1000ft. or more. The piers are 1100ft. long from the bulkhead line out to the pierhead line, and are 125ft. in width, the intervening slips being 400ft. wide. To provide for such piers and for slips that would afford a 46ft. depth of water at low tide, and to keep the outer ends of the piers within the pierhead line prescribed by the War Department, necessitated excavating the water front inshore to 12th Avenue. This entailed removing the outwardly slanting ledge of rock to a maximum depth of 56ft. That work was done in the dry and within an enclosing cofferdam approximately 2040ft. in length.

The 46ft. low-water contour line of the rock in the slip occupied by the U.S.S. "Lafayette" is about 365ft. offshore from the bulkhead line, at the axis of the slip, and the forward end of the vessel is pivoted on the rock at that point, and the stern has settled into the mud beyond. This movement raised the bow as the stern dropped deeper and deeper into the yielding silt of the North River. This posture directly adds to the problem of the salvors.

The fire that led to the extensive damaging of the three upper decks of the ship and to her ultimate sinking was caused by sparks from a metal cutting torch used in severing one of several steel columns in the grand salon of the liner. In that somewhat cluttered part of the ship, due to the work of conversion still under way, were nearby piles of kapok life preservers, which were wrapped in tar paper and baled in burlap. Once ignited, the combustible materials burned rapidly, and fire-fighting facilities then available aboard the craft were totally inadequate to arrest the spread of the conflagration. The flames attained formidable headway before the fire boats and the shore pumpers reached the scene. Such, in brief, was the cause of the fire that led to the sinking of the U.S.S. "Lafayette." Later, metal cutting torches were responsible for the two fires that occurred on March 13th and on April 18th. The earlier of these did little damage and was quickly extinguished, but the one on April 18th was put out only after three and a-half hours. It was low in the hull and could be reached only after a number of holes were burned through the upturned starboard side, below the normal water line. One of the contributive reasons for the first fire was the urge for haste in converting the luxury liner for military service.

The Navy Department's decision to attempt the salvage of the U.S.S. "Lafayette" was made in response to a report submitted by a special committee organised to consider how to deal with the great sunken craft. That committee was composed of the following members :—J. Barstow Smull, chairman



POSITION OF THE "LAFAYETTE"

of the well-known shipping firm of J. H. Winchester and Co., Inc., New York City; W. F. Gibbs, of Gibbs and Cox, naval architects, New York City; Rear-Admiral H. S. Howard, U.S.N., Bureau of Ships, Navy Department; Rear-Admiral H. L. Vickery, U.S.N., Maritime Commission; Rear-Admiral George H. Rock, U.S.N., retired, Administrator of Webb Institute of Naval Architecture; Albert V. Moore, president, Moore - McCormack Lines, Inc., New York City; Professor H. L. Seward, Yale University; and Commander William A. Sullivan, U.S.N., secretary of the committee.

The U.S.S. "Lafayette" has an overall length of 1028ft., a water line length of 981·4ft., and as a merchant vessel she was classed as of 83,423 tons. At the time of her sinking, after the removal of many of her luxury features and other fittings and weights, the ship had a displacement of 56,000 tons. This has been further reduced about 2000 tons by extensive stripping of her original structure above the promenade deck.

The text that follows is substantially that of the official report made public by the Navy Department when announcing the determination to essay the salvage of the erstwhile liner. The U.S.S. "Lafayette" lies at an angle of 80 deg. on its port side and rests diagonally in the slip between Piers 88 and 90. The keel at the stern of the craft cuts under the north side of Pier 88, where it broke five of the piles at the riverward end of that pier. The outer end of Pier 88 will have to be demolished in part to facilitate the righting operations on the vessel. The bottom of the slip in which the vessel lies has a formation and character that will contribute considerably to the complexity of the salvage operations. Bedrock is at a level of —160ft. (low-water level) under the ship's stern. At the same location hard sand is found at —105ft., and mud of varying consistencies overlies the sand. Toward the shore line the bedrock rises at a uniform slope and reaches a minus level of 46ft. at a point about 250ft. abaft the bow. From that point to the bulkhead line, at the head of the slip, the bedrock was cut away from the ledge rock shelf on a uniform level of —46ft., and the mud line in the slip, on that rock, shows a depth of 36ft. of water. The mud, as indicated by samples taken from end to end of the slip, is of a very fluid consistency.

Considerable time and research have been devoted to a study of the mud conditions under the ship and to the manner in which the weight of the ship was distributed on the bottom. Borings were made at various points along the vessel's side, and samples of mud at different levels have been recovered and analysed. The findings are thus disclosed by the official report :—

(1) That although the greater portion of the weight of the ship is resting in mud, there is an appreciable concentration of load at the edge of the rock shelf.

(2) That the intensity of pressure obtained at some places under the after portion of the ship exceeds the maximum bearing capacity of mud samples taken from adjacent borings at similar levels.

Ever since the ship heeled over transit records have been taken regularly of the ship's position in the slip, and these records show a steady settling of the stern with a corresponding rise of the bow, the fulcrum of the motion being at the edge of the rock shelf (the offshore limit of the excavated rock).

The change in trim, which is thus occurring, combined with the known fact that the mud under the after end of the ship is overloaded, indicates the following :—

(*a*) That nothing should be done in the slip to disturb the mud and so cause a lessening of its ability to support the weight of the ship.

(*b*) That the work of lightening the stern be either expedited or that some lost buoyancy in the middle portion of the ship be restored as soon as possible.

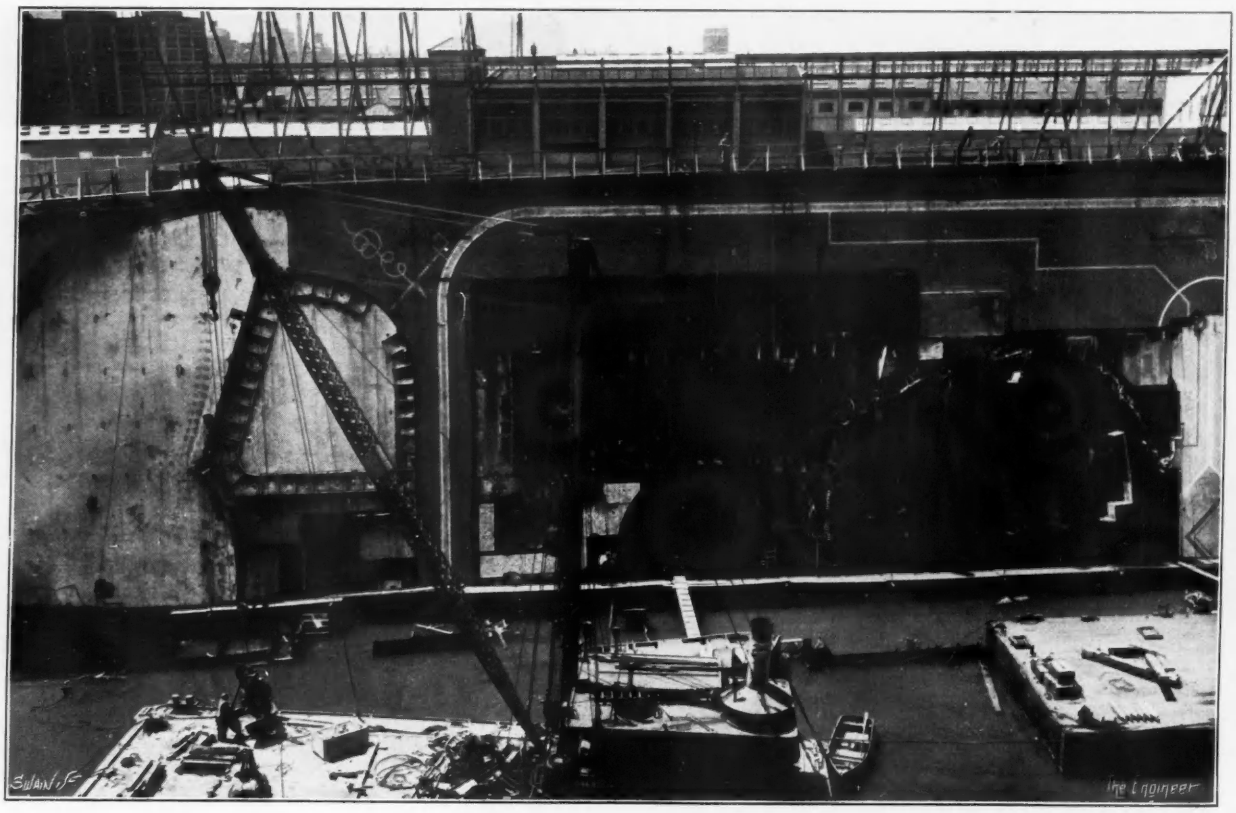
(*c*) That before any attempt is made to right the vessel enough lost buoyancy be restored to eliminate the concentrated loading which now occurs at the edge of the rock shelf.

Largely because of the complication due to the character and formation of the bottom, it has been decided that the most practicable salvage method to use is that of controlled pumping, so that the list and trim of the vessel as it is floated and righted will always be under control. This decision was reached only after a thorough study had been made into all of the various circumstances which influence the salvage problem and into various other possible salvage methods. In making the study advice was obtained, in their particular specialities, from some of the leading authorities in this country on certain phases of the work. Hundreds of letters with suggestions were submitted by the public, and each of these was reviewed and duly considered.

To float and to right the U.S.S. "Lafayette" by controlled pumping will not be a simple matter, even though that method is con-

SALVAGE OF THE U.S.S. "LAFAYETTE," EX "NORMANDIE"

SALVAGE OF THE U.S.S. "LAFAYETTE," EX "NORMANDIE"



sidered likely to prove a quicker, less expensive, and a more probably successful one than any of the other methods proposed and investigated. To raise the ship in that way all openings in the outer hull and in the promenade deck, now under water, must be closed and made water-tight with patches that will be strong enough to withstand the inward water pressure to which they will be subjected. In addition, that part of the promenade deck which is now under water must be reinforced from the main deck by shores to enable it to withstand external water pressure. To control the list and the trim of the vessel as she comes afloat the movement of the free water remaining in her must be restricted both by fore-and-aft and by transverse bulkheads. One of the lower intermediate decks, now that the ship is on her side, can be used for the required fore-and-aft bulkhead if the hatches and other openings in it, at present submerged, are blanked off. The necessary number of transverse bulkheads can be provided by extending to the promenade deck and to the existing water line several of the structural transverse bulkheads. The transverse bulkheads, with the exception of a few near the ends of the craft, now terminate at the D or E deck. To permit proper drainage to the pump suctions, numerous holes must be cut under water in those decks and bulkheads which will not be used to form the subdivisions for controlled pumping. All this preparatory work will have to be done by divers, and most of it by divers working inside the ship. The difficulties which they will experience will be great. They will have to work entirely by sense of touch, for the silt content in the water is so great that it will block the light of even the most powerful under-water lamps.

Before any appreciable amount of constructive diving work can be commenced within the vessel it will be necessary to clear out the under-water compartments of the mud and the *débris* with which most of them are more or less filled. When the ship heeled over approximately 10,000 cubic yards of mud entered her through open or broken air ports, cargo ports, and deck hatches. Furthermore, all loose or inadequately secured furniture, tools, equipment, ornamental fittings, screens, and bulkheads fell to port. Most of the resulting *débris* is now mixed with mud and in the lower part of the ship. Included in this mess is a considerable quantity of broken glass, which will endanger air hose and diving dress of the divers until it is removed. At the same time, a large number of partition bulkheads and a goodly quantity of ornamental sheathing and deck insulation, which would interfere with the accomplishment of the preparatory salvage work, must be cleared away.

Before the cleaning out of the flooded sections of the vessel can be essayed, accessibility will be restricted to passages in the unsubmerged parts of the vessel. With the ship inclined at an angle of 80 deg. entrance will therefore be by way of hatches and uptakes in such of the promenade deck as is above water and through cargo ports on the starboard side of the craft. Once inside the ship, access to different sections will in the main be through fore-and-aft passageways. The width of most of these passageways, however, is insufficient with the ship on her side to permit anyone to walk upright in them.

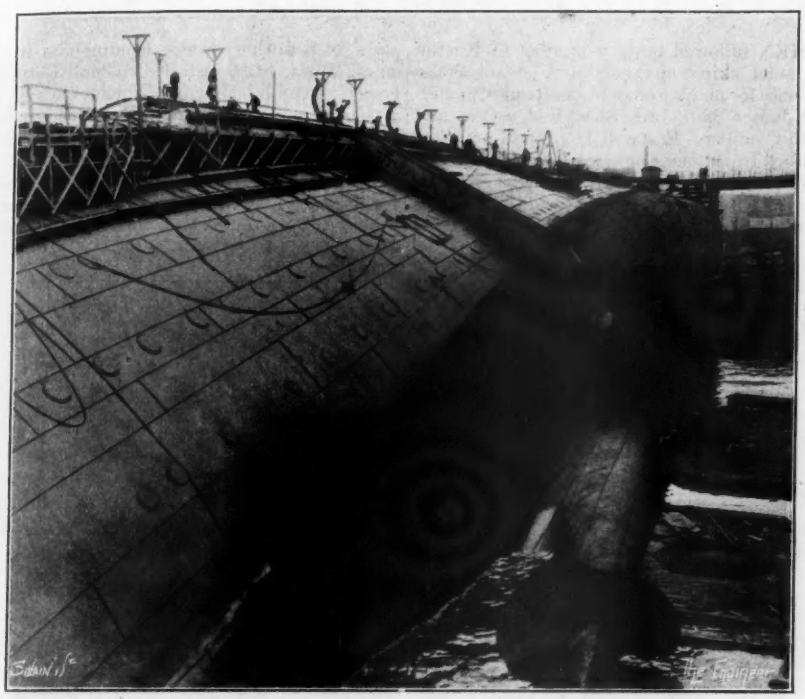
Furthermore, the bulkheads which now separate these passageways from adjacent spaces are mostly light partitions that lack adequate strength to serve as footways or decks. To provide the necessary accessibility throughout the interior of the craft will require the removal of many of these light partitions and the installing, instead, of a considerable amount of staging and numerous ladders. This latter work is now well advanced. It has been undertaken in connection with the elimination of the serious fire hazard which has existed in the ship. The vessel is still more or less filled with inflammable materials. The decks in the living spaces are covered with cork insulation, and the undersides of many of the decks are sheathed with ornamental woodwork of a flimsy character. The sides of the ship in way of the living spaces are also sheathed with cork, and there is a considerable amount of wood, plastic sheathing, and fabric covering and drapes.

The work of removing the structure above the promenade deck has been virtually completed in all those parts accessible above the present water line. The removal of the adjacent under-water parts of the ship's structure above the promenade deck will not be expedited until the submerged hatches in the promenade deck have been blocked off nor before some of the ship's lost buoyancy has been recovered by the removal of water now in her. The removal of these upper decks will lower the centre of gravity of the ship, when afloat, and will also decrease the moment needed to right her.

The salvage of the vessel by the controlled pumping method will include the following itemised operations :—

Complete removal of the structure above the promenade deck.

Clean out all inflammable materials, stores, miscellaneous woodwork, &c., above water,



STERN OF THE SUNKEN LINER

PLATFORM ON UPTURNED SIDE OF SHIP

and provide staging and ladders to give the required accessibility.

Clean out the under-water portions of the interior of the vessel to provide the accessibility needed for the divers.

Close with timber, steel, or concrete patches approximately 375 air ports, fourteen cargo ports, and miscellaneous scupper and drain-pipe openings under water in the port side of the ship.

Remove approximately 10,000 cubic yards of mud from the lower port side compartments.

Close with timber, steel, or concrete patches about 500 different openings in the port side of the promenade deck and fit shores as necessary between this deck and the main deck. Rip out all sheathing on the underside of the promenade deck and remove the cork insulation on the top of the main deck in way of this shoring.

Close all hatches and other openings in one of the lower decks to form a fore-and-aft trimming bulkhead.

Trace and close off miscellaneous vent trunks and pipe lines as required. Shore certain machinery bulkheads, uptakes, &c., as necessary. Search out, inspect, and make tight all under-water manholes to tanks. Connect up, as necessary, piping to tanks. Cut drain holes in decks and bulkheads as needed to eliminate water pockets.

Extend to the promenade deck on the port side of the centre line certain transverse bulkheads by fitting timber or concrete bulkheads between decks. Strengthen decks in way of bulkheads, if necessary. Shore existing bulkheads as required.

Remove a section of the offshore end of Pier 88 to permit the vessel to right herself and then to replace the pier structure when salvage is completed. Dredge slip to restore it to usable condition.

Install the necessary pumps and a system of suction and discharge pipes to permit the water level in each of the subdivisions of the ship to be under control at all stages of the salvage operations.

The steps just described will call for diving work on a scale never before undertaken, and a sufficient number of experienced divers to deal expeditiously with this immense salvage job is not now available. Therefore a school of training both civilian and naval men has been established on Pier 88 for the necessary salvage personnel. This has been arranged for by the Bureau of Ships and the Bureau of Naval Personnel. Fourteen young officers, recently graduated in engineering, have been assigned to duty on the pier, where they are receiving a special course in naval architecture and will be used as junior foremen on the work in progress. When they finish the course in naval architecture they will be qualified in diving and then they will be given instructions in salvage engineering. Seventy-five enlisted artificers of the Navy have been detailed to this special diving school for training preparatory to assigning them to work on the salvaging of the U.S.S. "Lafayette." The greater part of the salvage work, however, will be done by the civilian employees of the contractor for the Naval Salvage Service.

Commander William A. Sullivan, U.S.N., is in immediate charge of the salvage operations on the ship.

Canada's Untapped Metal Reserves.—The Canadian War Metals Advisory Committee is preparing an inventory of the mineral resources of Canada. Special attention is being paid to the possibility of opening deposits which were once considered unprofitable. New desposits are also being studiously investigated.

Excavating Machinery in the Ironstone Fields

By W. BARNES, M.I. Mech. E.

No. II

(*Continued from page 111, August 7th*)

THEN followed quite a number of Ruston steel skip conveyors and steam crane navvies for many ironstone companies, including James Pain, Ltd., Sheepbridge Coal and Iron Company, Eastwell Iron Ore Company, Pilton Ironstone Company, Kettering Coal and Iron Company, Ltd., Towcester Ironstone Company, Lord St. Oswalds Ironstone Company, Lysaghts Ltd., Westbury Iron Company, Redbourne Coal and Iron Company, and Richard Thomas, Ltd.

Referring back to 1904, Westbury Iron Company purchased a second-hand 8 H.P. Ruston tower type navvy with 1¼ cubic yard bucket for removing overburden, which was loaded into rail dump wagons and taken in trains to the spoil bank.

In 1905 Lord St. Oswalds Ironstone Company, of Scunthorpe, now Frodingham Ironstone Mines, Ltd., installed a small German Lubecker combined endless bucket excavator and belt conveyor for removing overburden consisting mainly of sand—Fig. 8. This machine worked successfully for many years, but eventually the cover became too deep for it and it was discarded in 1917 and replaced by a larger machine of a similar type made by Henry Berry and Co., Ltd., Leeds, to the designs of D. Whitaker. This machine is still in service, although it has recently (in 1942) been electrified.

Fig. 8—Lubecker Endless Bucket Excavator and Belt Conveyor—1905

Another Lubecker combined machine, exactly similar to the one supplied to Lord St. Oswalds Ironstone Company, was purchased in 1909 by Frodingham Iron and Steel Company, Ltd., for similar working

Fig. 9—Grossmith's Excavator—1907

conditions. This machine, after being idle for several years, was recently put to work again for occasional use.

A much larger endless bucket excavator and conveyor made by Taylor and Hubbard, of Leicester, was installed by the Frodingham Iron and Steel Company in 1913. The conveyor was 130ft. long, for a working depth of framing. The bucket arm was pivoted to the boom at a fixed radius. In place of the usual bucket a large circular cutting drum was employed. The circumference of the drum was fitted with teeth, which were designed to excavate the material and deposit it into a trough built into the radial arm. The "trough arm" was fitted with a scraper

FIG. 10—GROSSMITH'S WHEEL CONVEYOR—1907

about 60ft. The total weight was approximately 140 tons. It was used only for a comparatively short time. This excavator was designed so that the bucket ladder could be worked above or below the working level of the machine.

In 1905 Lloyds Ironstone Company felt the need of a larger and more powerful machine than the old Wilson steam navvy for digging ironstone and installed an American railway type steam shovel made by the Atlantic Equipment Company. The "railway type" shovel has a long framing with rail wheel mountings. The top of the framing carries the boiler and the necessary steam engines and machinery for digging and swinging, with a front end digging equipment, which only revolves through a little more than half a circle, but this particular machine was constructed so that the framing carrying the machinery could be swung round end for end upon a special framing carrying the bogies and travelling gear to avoid having to turn the complete machine round at the end of the cut, or alternatively having to travel it back to the commencement of the cut. Two more Atlantic steam shovels were purchased by Lloyds Ironstone Company in 1911, but they were supplied with standard framings.

Other American machines of the railway type, a Bucyrus and a Marion, were purchased in 1918 by the Oxfordshire Ironstone Company for excavating ironstone in the deposits it is working near Banbury. A second-hand Marion machine was also purchased from war stock in France by Lord St. Oswalds Ironstone Company for use in its Scunthorpe mines in 1919.

During 1907–8 A. R. Grosmith, of Lloyds Ironstone Company, made a bold attempt to solve the stripping problem by designing and building two extremely ingenious machines, an excavator and a transporter—Figs. 9 and 10. The digging equipment of the excavator was revolved or rotated through practically a full circle by means of wire ropes fitted around the outside of the swing circle, the ends being anchored to each side of the boom foot.

The boom was of the lattice type and was fitted at the foot with rollers which revolved upon a swing circle on the circular bottom conveyor, which carried the material along the trough to a chute, down which the material was discharged on to an annular ring, designed as a circular conveyor, which was supported about two-thirds of the way up a conical tower on the bottom framing. The framing was fitted with four large traction wheels, which were separately driven and steered so that the machine could be easily travelled and steered in any direction.

The digging action was as follows:—The arm, equivalent to the bucket arm of a power shovel, was lowered to a more or less vertical position with the cutting drum resting upon the ground at the bottom of the digging face. As the cutting drum slowly rotated the arm and drum were gradually raised at a speed coincident with the rate at which the teeth on the cutting drum could excavate the material, which, as previously mentioned, was conveyed along the arm in a steady stream down the chute on to the circular conveyor, which was slowly rotated by means of a circular rack until the material reached a plough at a point opposite to the boom, where it was discharged into a circular feeding pan attached to the conveyor.

The conveyor consisted in principle of a circular wheel, 70ft. in diameter, almost like a huge cycle wheel, with steel wires as the spokes. The material was slowly fed from the feeding pan on to the flat rim of the rotating wheel until it reached an adjustable plough at a point almost opposite the feeding pan. Here it was ploughed off on to the ground, from which the ironstone had been removed on the previous cut.

Unfortunately, the cutting drum and the conveyor on the arm of the cutting drum arm failed to function in practice, as it was intended to do, and an ordinary shovel bucket and arm were substituted for them. This method, however, proved too slow in practice and the excavator was scrapped, its place being taken by a Wilson steam crane navvy. The combination of steam crane navvy and circular conveyor was used for several years but eventually the wheel conveyor was also discarded.

(To be continued)

The Avro "Lancaster" Heavy Bomber

No. I

LAST week we accepted the invitation of the Ministry of Aircraft Production to see in production and in the air the latest addition to the Bomber Command aircraft, the "Lancaster" heavy bomber, designed and built by A. V. Roe and Co., Ltd. Recently, Mr. Winston Churchill, the Prime Minister, spoke of the unprecedented ordeal which German cities and towns will have to withstand by bombing in the coming months, and it will be in the enforcement and maintenance of this ordeal that the "Lancaster" will play an ever-increasing *rôle*. In this new bomber the United Nations have a vehicle of aerial destruction unparalleled in the history of the world, and to be produced in such numbers that it will rapidly take its place in the forefront of the weapons which, together, will bring victory to the Allied cause.

Already, but a few months after its completion, the "Lancaster" has left its mark on the German landscape and its people. It has helped powerfully by night to batter Cologne and Essen, with bombs of the heaviest calibre. By day it carried out the epic raid led by Squadron Leader J. D. Nettleton, V.C., on Augsburg, and the raids on Danzig and Flensburg. Its future achievements depend upon the decisions of Bomber Command.

DEVELOPMENT

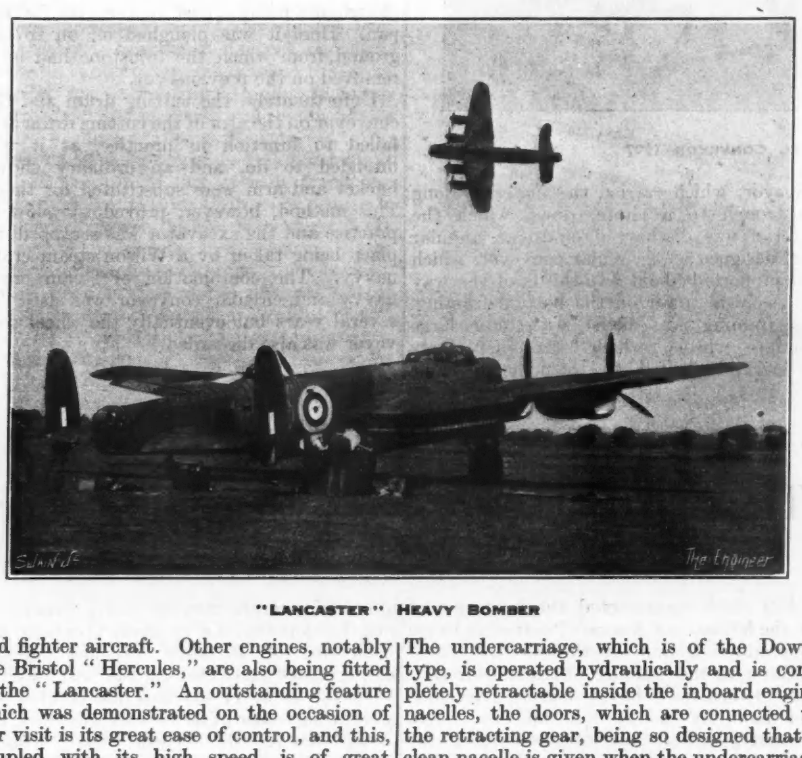
Behind the design and construction of the "Lancaster" there lies some thirty-two years of aircraft manufacturing experience and development, for the Avro Company has been one of Britain's foremost aircraft constructors since before the last war of 1914–18. In every way this new bomber is a worthy successor of its famous ancestors, the Avro "504 K," the "Tutor," the "Anson," and the "Manchester," the last of which was fully described and illustrated in our issue of June 5th last. It was on the basis of the "Manchester" that the whole of the technical staff of A. V. Roe and Co., under the leadership of its managing director, Mr. R. H. Dobson, C.B.E., F.R.Ae.S., set to work to produce the "Lancaster." In record time the drawing-office, led by the company's chief designer, Mr. R. Chadwick, F.R.Ae.S., produced the necessary drawings, while Mr. C. E. Fielding, another of the company's directors, whose special interest is the planning and processing of the work, ably backed by Mr. S. D. Davies, B.Sc., A.F.R.Ae.S., and his team of fellow-workers in the experimental department of the works, broke all records in the manufacture of the prototype aircraft. Thus it was that the new bomber was designed and built in record time, and may be justly looked upon as a triumph in aeronautical engineering.

From the initial flights and the report of the Ministry of Aircraft Production testing staff it was soon obvious that the Allied cause had now what has since been aptly styled by many pilots a "war winner."

The "Lancaster" heavy bomber is now in production in many factories of the Avro group, and in the factories of other large British aircraft manufacturing firms. It is also being built in one of Canada's largest aircraft factories. Thus many thousands of men and women are toiling by day and by night to produce more and more "Lancaster" bombers at an ever-increasing rate.

General Design and Construction

As will be appreciated from the accompanying engraving, showing one of a series of "Lancasters" on the ground, with another circling round in the air, the new bomber has particularly graceful lines and a pleasing appearance, perhaps rarely seen in large military aircraft. In design it may be described as a mid-wing four-engined all-metal cantilever monoplane, with a retractable undercarriage. In general, it is powered by four Rolls-Royce "Merlin XX" liquid-cooled engines, which have given such a good account of themselves in other bombers and fighter aircraft. Other engines, notably the Bristol "Hercules," are also being fitted to the "Lancaster." An outstanding feature which was demonstrated on the occasion of our visit is its great ease of control, and this, coupled with its high speed, is of great defensive value. Heavy defensive armament is also carried in four Parnall power-operated gun turrets working on the Fraser and Nash hydraulic system.



"Lancaster" Heavy Bomber

Principal Dimensions

Span	102ft.
Length	69ft. 4in.
Height	20ft.
Gross wing area	1297 square feet
Depth of fuselage	8ft. 2in.
Width of fuselage	5ft. 9in.
Main undercarriage wheel	5ft. 6in. diameter
Length of bomb compartment in fuselage	33ft.
Weight of aircraft fully loaded	Approx. 30 tons
Maximum speed	Approx. 300 m.p.h.
Maximum range	Approx. 3000 miles
Maximum bomb load	Approx. 8 tons
Type of engine	Rolls-Royce "Merlin XX"
Number of engines	Four
Maximum power with low gear supercharger	1260 B.H.P. at 12,250ft.
Maximum power with high gear supercharger	1175 B.H.P. at 21,000ft.
Type of airscrew	Three-bladed, 13ft. diameter, fully feathering
Armament: Four Parnall gun turrets, one in nose, one mid-upper, one mid-under, and one in the tail	
Number of guns	Ten Browning, 0·303in.
Number of crew carried	Can be seven

The keynotes of the "Lancaster" design are ease of production, easy transport, and easy maintenance and repair. The design, the makers claim, lends itself to rapid and relatively cheap production, as the entire machine is built up of numbers of components which are manufactured largely as separate and self-contained units, and are easy to transport and to assemble. Full 100 per cent. interchangeability has been aimed at and achieved, and this, coupled with ease of construction, has contributed largely to the ease of maintenance and repair. The fuselage is built up of transverse formers with continuous longitudinal stringers, whilst the main wing is of two-spar construction, each spar consisting of a top and a bottom extruded boom bolted on to a single thick-gauge web plate. The wing ribs are made from aluminium alloy pressings, suitably flanged and swaged for stiffness. The tail-plane is built on similar lines to the wing, with twin fins and rudders at its extremities. The entire surface of the aircraft is skinned with aluminium alloy sheets secured by flush riveting, giving a smooth external surface.

The undercarriage, which is of the Dowty type, is operated hydraulically and is completely retractable inside the inboard engine nacelles, the doors, which are connected to the retracting gear, being so designed that a clean nacelle is given when the undercarriage is retracted. Fuel is carried in six self-sealing fuel tanks, enclosed in petrol-tight welded aluminium sheet casings, which are carried in the wings of the machine. De-icing equipment is also fitted. At the centre section trailing edge portion of the wing a dinghy is stowed, which is automatically freed when making a crash landing, while provision for hand operation is also made.

As in the previous heavy bombers we have already described, the interior of the fuselage is equipped to meet all modern requirements. A canopy is fitted over the pilot's cockpit, which gives an excellent view in all directions, including aft. Inside the canopy immediately aft of the pilot's seat is the fighting controller's position, which again is provided with views in all directions. Slightly aft of this position is the navigator's station, with a table and provision for charts. There is an astral dome in the roof of the cabin. The wireless operator's station is at the rear end of the navigator's table, just forward of the front spar.

An armour-plated bulkhead is fixed across the centre section of the fuselage at this point, and it is so designed that it can be opened for access on either side of the centre line. The back of the pilot's seat is armour plated, and there is also an armour plate behind his head. Certain other vulnerable parts of the aircraft structure and also parts of the gun turrets are armour plated, whilst at the fighting controller's position special bullet-proof glass is fitted in order to provide added protection.

Within the centre section of the fuselage the oxygen bottles are stowed in a crate, the top cover of which is upholstered and provides a comfortable rest bed with an adjustable back rest. Aft of the rear spar a mid upper turret and a mid under turret are fitted, together with the various equipment stowages for flares, emergency rations, &c. The ammunition boxes are placed in this portion of the fuselage and ammunition is transported to the tail turret by means of tracks. A robust walkway along the entire length of the fuselage is provided, and the entrance door is on the starboard side, just forward of the tailplane. The fuselage is entered by a ladder which is stowed during flight. At various suitable points throughout the fuselage there are escape hatches for all members of the crew.

The bomb aimer's station is in the nose of the fuselage below the front turret and forward of the pilot's cockpit. All the bomb-sighting equipment and bomb-release gear is fixed in this compartment, and the bomb aimer takes his sight through a clear-vision window made of laminated glass optically ground. The bomb compartment is contained within the fuselage form, and the cabin floor above, which is of robust construction and constitues the backbone of the fuselage, is specially designed to take the housings to carry the various types of bomb employed. The two doors which open and close the bomb compartment are hydraulically operated. A further point of interest in connection with the bomb doors is that the electrical circuits are so arranged that the bombs cannot be released until the bomb doors are open. In cases of emergency or in case of a possible failure in the hydraulic system, the bomb doors and also the retractable undercarriage can be operated by means of an emergency compressed air system. There is intercommunication between all the members of the crew, and there are readily accessible stowages for parachutes provided at all the crew stations, along with easily reached oxygen points.

In our next article we hope to deal with the production of the bomber in the workshops and the assembly bays.

(To be continued)

A Locomotive Conversion.—An interesting locomotive experiment has been undertaken by the Baltimore and Ohio Railroad with the modernisation of three of its 2–8–2 freight engines, in order to fit them for exacting present-day schedules. *The Railway Gazette* says that in converting "No. 4482" from Class "Q-4b" to Class "Q-4c," the 5ft. 4in. driving wheels have been increased to 5ft. 10in., the cylinders from 26in. by 32in. to 26½in. by 32in., and the working pressure from 225 lb. to 240 lb. per square inch. Two later conversions now have 27in. cylinders and 230 lb. pressure. Tractive effort has increased from 63,200 lb. to 65,500 lb. Lubrication and balancing have been improved, and the equipment includes Baker valve gear, power reversing, and mechanical stoking. An eight-wheel Vanderbilt type tender has been fitted, with accommodation for 15,000 gallons of water and 32 tons of coal, as compared with 12,000 gallons and 17½ tons previously, and, in addition, a bogie tank car, containing 10,000 gallons, is coupled to the rear of the tender, raising the total water capacity to 25,000 gallons. The supplies of coal and water are thus equal to those of the largest tenders in use in the U.S.A., and the modified locomotives will be able to operate over considerable distances without refuelling or rewatering.

Royal Ordnance Factories

ON August 5th, Sir Andrew Duncan, Minister of Supply, delivered the following speech in the House of Commons :—

Before I refer to the Eleventh Report of the Select Committee on National Expenditure in detail, I think it would be for the convenience of the House that I should give a further brief picture of the dimensions of our Royal Ordnance Factory organisation. There are forty-two Royal Ordnance Factories, of which twenty-four are engineering, eight make explosives, and ten are engaged in filling. They employ 300,000 people, 60 per cent. of whom are women, 32½ per cent. semi-skilled and unskilled men, and only 7½ per cent. skilled men. The engineering factories engage in a very wide range of high-precision work. They make guns, gun carriages, small arms, the components for gun ammunition, and small arms ammunition, but their principal output is guns. At the present time they are responsible for 66⅔ per cent. of the total gun output of the country, whereas a year ago they were responsible for only 50 per cent. of the total output. With improvement in efficiency, with more workers coming into employment, with improvement in design and with the mass production of components in associated factories, the output of guns has gone up very considerably indeed, and to-day the Royal Ordnance Factories are producing from the gun factories four and a-half times as many guns as they were producing twelve months ago. One factory alone to-day is producing a number of guns equal to 75 per cent. of the total number per month that were produced throughout the whole country in the last war when production was at its peak, and overall the Royal Ordnance Factories are to-day producing twice as many guns as they were originally rated to produce. They have, therefore, become a powerful and very flexible instrument of production, and great credit is due to the Director-General of Ordnance Factories, who has the prime responsibility for the running of these factories.

On the explosive factory side we make something like 60 to 70 per cent. of the total explosive output of the country, and it is a long time since the supply of explosives gave us any trouble. In no case at the present time is the filling of shells, bombs or cartridges in any way limited by the supply of the principal explosives. Whereas the skill of our engineering industry in this country was a very sound foundation for our gun making, there was really no counterpart on the filling side and the development of filling factories was behind the development of gun factories at the outbreak of war. The rapid growth of these factories, therefore, has accentuated to a considerable degree the difficulties that are in any case inherent in this kind of industrial activity. Individual factories have been recruiting five, six, or seven thousand people, and the total personnel of most of these factories ranges from 10,000 to 25,000 persons. Not only is the labour new to the technique of filling, but a great proportion is new to factory life altogether. By the end of 1941 these factories could be said to be completed and at the beginning of 1942 we agreed a programme with the War Office for the requirements for the whole of 1942 and set a target figure for them. The target figure was deemed by many of our factories to be too high, but I am glad to be able to say that by the end of June the rate reached was 98 per cent. of the target and with the rise in output there should be no difficulty at all in more than meeting the requirements for the full year.

During the last twelve months we have recruited 66 per cent. more people into our Royal Ordnance Factories engaged in filling. We now have two and one-third times the production of a year ago, and what is very interesting and important is that the increase in output per individual operating in these filling factories is 40 per cent. more than it was a year ago. There is really no peacetime parallel to a development and production of this kind, and the variations which take place in war, whether by land or air or sea—the filling factories serve all three Services—make changes in programme from time to time quite inevitable, but as in the gun factories so in the filling factories we are now in a strong and flexible position to meet all sudden developments.

However gratifying our production results may be, neither the Minister nor a departmental head would have any right to do anything but welcome help from any review made by a detached or representative Committee of this House. We would not wish to fail either in appreciating or accepting guidance which makes for the improved efficiency of this national organisation. It is not possible, however, to accept all the statements made in the Report as statements of fact nor is it possible to agree that, in reaching their conclusions, the Committee had in mind all the material considerations that were bound to be in the minds both of Ministers and departmental heads at the time when decisions had to be taken.

With regard to the Report itself, I shall take first the large range of questions which relate to filling factory capacity, to labour in the filling factories, and to the hostels.

On the question of filling capacity, there was a period in the war when on any prudent calculation the present filling capacity would have seemed likely to be quite inadequate. Indeed, at one stage a much larger number of factories was contemplated. On present requirements and in the present state of the ammunition programme, we have, it is true, some surplus of filling capacity. That surplus constitutes a necessary, valuable, and wise insurance. If there were no occupational hazards in this industry, if there were no hazards from the air, and if there were no hazards of other kinds we might well concentrate more than we have done, although even then there must be practical limits to concentration. I am, however, very glad to observe that the Committee do not put their recommendation higher than that the possibility of concentration should be carefully examined. It must be examined in the light of the uncertainties of the future and the possibilities of higher requirements. We do keep in the Department careful records of and a close watch on surplus capacity, even temporary surplus capacity. All buildings which are reasonably suitable for storage in these factories—many, of course, are quite unsuitable for it—have already been turned over to our storage branch at the Ministry of Supply and a great many of them are in use for storage purposes.

With regard to the labour requirements of these factories, there has been from the beginning until to-day the closest possible *liaison* with the Ministry of Labour. It is through the Ministry of Labour that we find our personnel for these factories, and it is to the Ministry of Labour that we intimate as far ahead as it is possible to do, that, owing to changes in programme or for any other reason, releases of labour will be possible when such releases are likely to take place. In regard to the question of miners at one of the factories named in the Report, I would like to make it clear, as my right hon. friend the Minister of Labour stated in answer to a question yesterday, that right at the beginning all ex-face workers below the grade of supervisor engaged in our Royal Ordnance Factories were made available to the Ministry of Labour when their transfer back to the mines was wanted. However, a great many of them—in fact, it would be fairer to put it the other way and say very few of them—were found to be within the physical age and other qualifications necessary for their return to the mines. Nevertheless, in accordance with the Select Committee's recommendation, we, with the Ministry of Labour, are prepared to accept the view that there should now be a joint survey, in detail, of these factories. We must not lose any chance of looking into things thoroughly. We have also asked the Ministry of Labour to join with us in investigating the question of the dilution and employment of women, which also was a recommendation of the Select Committee.

In regard to the recruitment campaign, to which reference is made in the Report, it was initiated last autumn in agreement with the Ministry of Labour. In the spring of this year we again consulted with the Ministry of Labour and greatly reduced activities of that kind engaged in by the Ministry of Supply. In answer to the recommendation made by the Select Committee we propose to close this section for special recruitment altogether.

In considering the recommendations and observations of the Select Committee as to hostels, I think it is necessary to remember how difficult it is to reconstruct the conditions that existed when decisions were first taken on these matters. I feel certain that members of the Select Committee will themselves agree that it is difficult completely to put their minds back to over a year ago. Efficiency in factories has greatly improved ; in fact, it has improved more than it was reasonable to anticipate, and that, of course, has meant that the numbers of workers required are less. There has been freedom from air raids, which has made it likely that people are willing to travel—and it certainly has made it possible for them to travel—much longer distances than they could have been expected to travel at the time when the severe "blitzing" was on, as it was when these hostels were originally planned. Transport has been excellently maintained ; one might almost say surprisingly well maintained. Concentration of industry and the registration of women have also made much more local labour available for these filling factories than was apparent before these steps were taken. For all these reasons I think we must, in considering what the Committee calls "this remarkable miscalculation," be guided rather by the advice given to us by the Select Committee in July, 1941, than by that given to us in 1942. In 1941 the conditions and the outlook were different and the advice was also different. Then the Committee recommended that the provision of hostels should be increased and speeded up as a matter of urgency.

In the light of the circumstances at the time it was the right thing for the Select Committee to do and the right thing for the Ministry of Supply to do. To think that there was any guesswork about this is to be under a misapprehension. The subject of hostels was very carefully considered in collaboration by the Ministries of Supply, Health, and Labour, and plans were only decided after the closest consultation with all the local people concerned. Even now, it would be quite unsafe to make any final assessment on this question of hostels. Circumstances may yet still change and all hostels may be required, but in the meantime fourteen out of the sixteen surplus hostels to which the Report refers have been taken over by other Departments, which have been extremely fortunately placed in having them. Seven of those which were suspended are now to be completed for other Departments. In regard to the hostels occupied by our own workers, careful attention will certainly be given to the Select Committee's observations. The managing associations in charge of these hostels give the closest attention to the psychological questions that arise and are striving all the time to improve the comfort and homeliness of the hostels.

Now, on the range of questions that relate to factory conditions and the smooth running of these factories, I must say that we are very conscious of the importance of the smooth and regular supply of components, to which the Select Committee direct our attention. I am glad to say that conditions in that respect have greatly improved. Both the output of ammunition and stocks of components has improved. Stocks of balanced sets are substantially higher than six months ago. The great majority of components and materials to be assembled into rounds of ammunition come from innumerable trade factories. Only a small proportion come from ordnance factories, and the closest attention must be given to the movement of this

large mass of components into the filling factories. Our machinery for ensuring that there is every care taken in the assembly and stocking of components is given very close attention.

With regard to the *liaison* that exists between the design and the production of components, I fully accept what the Select Committee says, subject only to one limitation, and that is that the user's purpose must be served. If every design by a producer were accepted as the last word, there is no doubt that the user's purpose would not be served.

All classes of components are inspected before despatch for filling. There must of necessity, of course, be occasional exceptions to that general rule, because of new designs having to be tried out on a larger scale than that of a small trial. I believe it is true that the case to which the Select Committee's Report refers was an exception in respect of small arms which was put right as far back as March of this year.

On the questions of factory performance, the exchange of information, and promotion to the grade of overlooker, we accept the Select Committee's recommendations. Attention is drawn by the Select Committee to economies which might be drawn from the unification of the Inspection Departments of the Admiralty, the Ministry of Supply, and the Ministry of Aircraft Production. As the Select Committee point out, there are considerable administrative and technical difficulties in effecting complete unification, but the advantages are realised, and considerable progress has already been made in this direction. A further development along those lines is now being discussed by the Ministry of Production and the Supply Ministries, and the House can rely upon us to give the fullest possible effect to the proposals and observations of the Select Committee. On the subject of time and motion studies and incentive bonus schemes, we are in general agreement with the Select Committee's observations and conclusions, but in suggesting that the embodiment of these methods should have taken place in the original lay-out, it seems to me that the Select Committee are overlooking that the bulk of these plans were made in the early and less knowledgeable days of the war. In so far as they can be incorporated in lay-out, of course, they should be. I think the Select Committee err also in thinking that even now the Ministry are giving more attention to time study than to motion study. But, subject to these reservations, I am bound to confess that I find the observations of the Committee on that subject a matter of great interest to us.

There are only two major questions in the Report that are left to be considered, both of them matters of very great importance. One is absence from work. There is no denying that absence from work is still a serious problem in Royal Ordnance Factories, particularly on the filling side, as it is in a great many other places where there have been large influxes of new labour, and particularly where large numbers of married women are employed. During most of the period covered by the review, these factories were receiving large influxes of new labour and there was less opportunity during that time to focus upon this problem as a whole the attention which we now give to it; during the last six months, however, close attention has been directed to it both at headquarters and in the factories. At headquarters a Committee presided over by my hon. friend the Parliamentary Secretary, the hon. Member for Rushcliff (Mr. Assheton), whose sympathy with and experience of these matters is well known, is giving constant attention to this question. A notable improvement has already taken place within the last few months, particularly in the lessening of casual absence—non-accountable absence—but the problem is not one that is easy of solution, particularly in those filling factories where there are very long distances for people to travel to and from work. In these days of curtailment of shopping facilities, and in view of the domestic and family circumstances and responsibilities of the women, one has to be tolerant and patient—indeed, it is only with patience that this improvement can be effected. Large numbers of these people have been rooted up from their normal environment and ordinary habits, and it is a delicate task to build them now into a real community in their new environment, and certainly it is a very difficult task to build them up into an industrial entity within which the importance of regular attendance at work is recognised as an element in the smooth running of the shop.

Headquarters can guide policy in these matters. They can examine the causes and they can formulate remedies. They can initiate ideas and they can effect interchange of experience. They can organise a steadier flow of work—and that is very important. Headquarters can do all these things, but it is in the factory itself that the real problem must be effectively tackled in the end. As the Select Committee point out in their Report, we now have a staff of labour officers in these factories who have been asked to give priority to the consideration of this subject. We also have, under the more recent Regulations and the Essential Work Order, absentee committees which are appointed in all these works. I would like to pay a tribute to the zeal and enthusiasm with which these committees are setting about their task. These are committees composed of representatives of the workers and managements who give weekly, and sometimes daily, study to the records of those who are absent and try to discover why they have been absent; the whole object, of course, being to avoid prosecutions, because prosecutions are in the end the least satisfactory method of dealing with this subject, and to ensure that there is throughout the factory an understanding of the need of regular attendance if a smooth flow of work is to be maintained. I would like to recognise the help we have had from the district officials of trade unions who have lent their weight by addressing meetings in the canteens. I would like also to acknowledge the very great assistance we have had from a number of hon. Members, who have taken special care of and interest in the factories within their constituencies. The Select Committee's observations on the whole range of this subject will receive most careful study, and in so far as we can benefit by the advice they give, we hope to do so. We had hoped that the initiation of a three-shift system in the filling factories and the lessening of hours generally would have given us greater relief on this question of absence from work than we have yet had from it. In thirty out of forty-two factories the hours are sixty or less for men and fifty-five or less for women, and reduction to these standards will be achieved, I hope, in the remaining twelve factories within the next three months. I accept the rebuke which the Select Committee's Report administers. The Government certainly should be an example in these matters, and the standard having been accepted, we should work to it as faithfully as we can. With regard to the effect on production per hour where the total hours per week have been reduced, it has really been very mixed, although I think a fair deduction would be that in course of time we are likely to get more output from those factories where the hours are reasonable. I do not think I could myself subscribe to any other view than that, and that is the aim we are now putting to ourselves quite definitely in respect of those factories that still have to have their hours reduced.

There remains only the question of the headquarter set-up of the Royal Ordnance Factory organisation of the Ministry. Originally the final authority for the whole range of Royal Ordnance Factories was vested in a Director-General of Ordnance Factories. A change which took place about a year ago was that the Director-General of Ordnance Factories, instead of having the responsibility for engineering, explosives and filling, now has responsibility for engineering and explosives and a certain administrative responsibility in relation to filling. A separate Director-General of Filling Factories was appointed with sole responsibility for production in the filling factories, and also with certain administrative responsibilities for them.

The filling factories were and are a special problem. They are quite distinct in their production from the other Royal Ordnance Factories. They have a safety element which compels ultimate responsibility of a very onerous character, and their labour is no more interchangeable with the engineering labour of the Ordnance Factories than with the engineering labour of other factories—in any case the release and interchange of labour is a matter for the Ministry of Labour. I would remind the House that the components and the flow of components is a matter of great importance and comes to these factories not, except in very small part, from engineering factories of the Royal Ordnance organisation, but from private factories all over the country. Therefore, in almost every sense, from the productive point of view these filling factories are capable of being regarded as a separate entity. The Director-General of these filling factories was formerly the Deputy Director-General. He is a man who has shown rare aptitude for leadership and has established a *morale* which is quite priceless in those sections which demand great care against internal accidents and great calmness in air raids. I wish I could give some details to the House of examples of fortitude shown in one of these factories in a recent air raid. The leadership which the Director-General of Filling has given in these matters is one to which I cannot pay too high a tribute. I am glad the Select Committee do not express disapproval of the work which the Regional Directors have done under the present Director-General of Filling Factories; indeed, they commend with appreciation the work which has been done. They feel, however, that the arrangement at the top looks lopsided. I have to admit that, as constituted at present, it does look lopsided, but lopsided things sometimes work very well, and this has produced very excellent results. I certainly must, in the light of what the Select Committee has said in the Report, be prepared, and I am prepared, to review the whole of this matter with the greatest possible care, but I feel it would be wrong to do it too hastily, because there are a great number of considerations involved.

That, I think, covers all the questions raised in the Select Committee's Report. I end as I began by saying that even if it is necessary to dissent from many of the statements and some of the conclusions, I accept the Committee's Report as constituting a call for stock-taking, both in the organisation and in the functioning of the national factory organisation. In a growth so speedy and so big, there may well be many directions in which, now that the mechanism is in full working order, its operations can be consolidated into a better ordered whole. Even so, I ask the House to pause before applying the ordinary standards of criticism of administrative competence without some reservations, not too many, for the emergency conditions under which so much of this has had to be done. I feel certain that the Select Committee would say that the improvements of this machine must be tackled with a sympathy and an understanding of the dimensions of many of the human problems which are involved. I would claim, however, that this country has every reason to be proud of this Royal Ordnance effort in productive State enterprise, and no one connected with it has any other ambition than that it should be made still more effective.

Spot Welding in Mild Steel*

The object of this memorandum is to provide a summary of the factors which affect the quality of spot welds, and to suggest methods of controlling and inspecting the quality. The following appendices, not here reproduced, accompany the memorandum:—(I) Nomenclature, definitions, and symbols for spot welding; (II) setting of spot welding machines; (III) specimen procedure schedule; (IV) electrodes and electrode tips; (V) spot welding

* From Welding Memorandum No. 8, "The Inspection and Control of Quality of Spot Welds in Mild Steel," issued by the Advisory Service on Welding, Department of the Controller-General of Research and Development, Ministry of Supply.

machines; (VI) automatic controllers for spot welding.

General

The spot welding process is described in detail in Advisory Service on Welding Memorandum No. 4, "Memorandum on the Use of Resistance Welding." In making a spot weld, the pieces to be joined are pressed between copper or copper alloy electrodes from which a heavy current at low voltage is passed through the sheets, inducing local heating to a plastic condition, so that under the applied pressure the two surfaces are welded together. This memorandum is intended to apply to materials having an added thickness not exceeding $\frac{1}{4}$in.

The main factors which affect the making of the weld are :—(*a*) The pressure; (*b*) the welding current; (*c*) the time of application; (*d*) area of electrode tip; (*e*) surface condition of material to be welded. It is the function of the welding machine to provide a means of controlling accurately the first three factors so that the consistency and uniformity of the welding is made independent of the operator, and dependent only upon satisfactory control over the surface condition of the material and the area of contact of the electrode tips.

Under the influence of high temperature and pressure, the electrode tips tend to spread and increase in area. It is necessary to keep constant —within certain limits—the current density through the sheets, and the pressure intensity between electrodes and sheets, and this is achieved by limiting the permissible wear on the electrode tips. In addition to the above

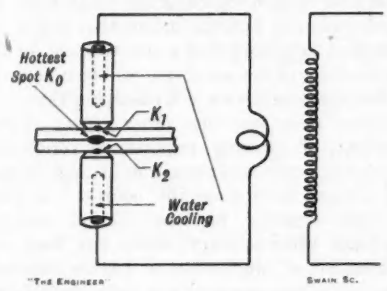


FIG. 1

variables, there is a further factor which may influence the formation of a weld. When a magnetic material is introduced into the throat of a welding machine, the effect is to increase the reactance of the welding transformer secondary circuit, resulting in a reduction of the welding current. The degree of this reduction of current increases with the amount of magnetic material introduced, and consequently spot welds made in the centre of a large sheet will require a different setting from those made nearer the edges. This point should be watched particularly when welding the seam of a long cylinder, as the fact that the lower electrode arm is encircled by magnetic material has an even more pronounced effect on the current.

The heating effect during the formation of a weld is proportional to :—The square of the welding current, the time of application, and the electrical resistance of the sheets being welded. The total resistance is made up of :—The resistance of the material itself, the contact resistance between the electrodes and the sheets, and the contact resistance between the sheets themselves (Fig. 1). Of these, the contact resistance between the sheets is the greatest and the most important and can vary widely according to the cleanness or surface condition of the sheets and the pressure applied—the resistance decreasing as the pressure is increased. In welding thick plate or stiff sections, the pressure must be sufficient to deform the plate or sections to bring them into intimate contact at the point where the weld is to be made, although the spot welder should not be expected to press out buckles in plates which have not been previously flattened. The material being welded must be clean, free from rust, dirt, or mill scale. Pickling and shot-blasting can be used for cleaning material to be spot welded. A thin film of oil is normally no handicap to success.

There are thus numerous interrelated factors affecting the making of the weld, and the object of this memorandum is to indicate how the variations can be kept within the necessary limits to enable sound welding to be done. For effective inspection and control of the quality of spot welding, the precautions to be taken will vary according to the nature of the article or structure to be welded. While it is usually possible by means of a combination of effective controlling devices in the machine and appropriate supervision and inspection methods to ensure a consistent product, it is by no means simple to set out the precautions to be taken in the form of a specification, except in relation to a particular job, because of the number of variables involved. In order that the requirements of the machine and the inspection methods may be related to the character of the service for which the spot welds are required, spot welding applications shall be classified as under :—

Class A—Where the failure of the spot welded joint would endanger the whole structure or where spot welding is applied to a primary structure and each weld is assumed to carry a proportion of the load.

Class B—All applications of spot welding not covered by Class A.

Plant

The plant recommended for use in relation to the above classification is as under :—

All welding machines shall be provided and used with an automatic timing device which shall be capable of controlling accurately the time of flow of the welding current under all workshops conditions. It shall be possible to set the welding pressure to any given value within the pressure range which the machine is capable of giving, and some means shall be provided to check that this pressure is maintained within ± 10 per cent. A device shall be incorporated ensuring that the current is switched on only when correct pressure is applied.

For work subject to the requirements of Class A the machine shall incorporate a control feature to ensure that pressure between the electrodes cannot be relieved until the full welding time has elapsed, and that the full pressure be maintained for a suitable period after the welding current has ceased to flow. Shanks of electrodes must be water cooled, and provision should be made for water cooling in accordance with B.S.S. 807—1938. Also it is recommended that the distance from the tip of the inlet water tube to the blind end of the water hole within the electrode shall not exceed $\frac{3}{8}$in., and the distance from the blind end of the water hole to the tip of the electrode shall not exceed $\frac{1}{2}$in.

Supervisor

Every contractor engaged on contracts embodying spot welding shall employ a competent supervisor who shall be held responsible for the quality of the spot welding, for the setting of the machines, and for making the necessary routine tests to ensure that the required standard of quality is maintained. He shall supply the welding operators with a procedure schedule, setting out :—(1) The manner and order of making the welds; (2) particulars of tip changing and maintenance; (3) particulars of the routine test coupons to be prepared and the method of testing and recording the results of shear tests on Class A work; (4) a standard specimen for purposes of comparison.

Operator

The operator shall :—(1) Make the spot welds in the sequence laid down; (2) change the tips regularly in accordance with the tip maintenance instructions; (3) make the routine tests as required.

Tip Maintenance

From time to time the operator shall check the size of the tip by means of a gauge or by measurement of the spot impression, and when the tip has reached the limiting size specified he shall change it. The tips shall be changed as under :—Class A, when the tip diameter has increased by 20 per cent.; Class B, when the tip diameter has increased by 40 per cent.

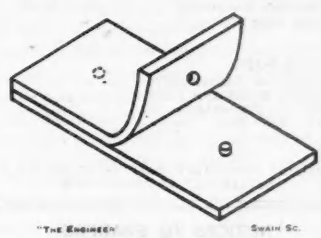
Tips must not be re-dressed in the machine (unless with a special milling cutter designed for the purpose, and then only if the travel of the moving electrodes is vertical), and the only treatment permitted shall be an occasional light rubbing with emery paper, not coarser than grade O. After changing tips, a check must be made to see that the flat surfaces bed evenly on one another when brought together with full pressure applied. Provision is usually made on fully automatic machines to permit this without current flowing, whereas with foot-operated machines the main isolating switch can be opened.

Routine Tests

Test welds shall be made regularly to check the consistency of the welding as under :—

The routine test shall be carried out by making one or more spot welds as nearly as possible under the conditions of the work, and testing them in a tensile testing machine and/or breaking them for examination. The welds shall be made on coupons designed to reproduce as closely as possible the conditions in the work, or, preferably, on work pieces set apart for the purpose. The test coupon shall be of the same material and of the same thickness as the workpiece and the machine setting shall be the same as for the work itself. The inspector should see the first store on which welding has been completed.

If not detailed in the specification for the store being manufactured, the routine tests



Weld diameter = average of D_1 and D_2.

FIG. 2

shall be made before and after each tip replacement unless decided otherwise by the inspector and supervisor. If a tensile testing machine is not used, then the test consists in breaking the weld by any convenient means, when the weld material must tear out from one part remaining as a slug or button on the other part. The average diameter of the slug at the plate surface, measured in two directions at right angles, must not be less than the prescribed weld size (Fig. 2).

For Class A welds, 5 per cent. of the test coupons shall be broken in a tensile testing machine, and the shear value of the test welds shall be in accordance with the drawing and/or in accordance with the values given in the following table :—

Weld diameter. Inch.	Minimum test failing load for each spot. lb.
$\frac{1}{4}$	414
$\frac{5}{16}$	924
$\frac{3}{8}$	1650
$\frac{7}{16}$	2586
$\frac{1}{2}$	2756
$\frac{9}{16}$	5040
$\frac{5}{8}$	6570

The Inspector shall also be entitled to select from completed stores a number up to 0·25 per cent., or at least two of the batch welded at one machine setting which can be broken open to provide confirmation that the design requirements are being met.

Visual Examination

The inspector shall ascertain that the welds are correctly placed and that the depth of indentation on either side does not reduce the plate thickness to less than 90 per cent. of the original value. The surface of the finished welds must be free from cracks or traces of tip material. Expulsion of metal between the sheets or between electrodes is undesirable, since it results in cavities. Welds shall not be placed on the edges of sheets since they usually show signs of metal expulsion.

Inspection procedure shall ensure that parts to be welded fit reasonably well and are clean and without scale or rust on the surfaces to be welded, and that all requirements as specified in this memorandum are complied with.

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Telegraphic Address: "Engineer Newspaper, Estrand, London." Telephone: CENtral 6565 (10 lines).

ROYAL ORDNANCE FACTORIES

WHEN, in the House of Commons, on August 5th, the long debate on the Royal Ordnance Factories came to an end, Mr. Tinker asked if there were any means by which some part of the reply made by Mr. Assheton, Joint Parliamentary Secretary to the Ministry of Supply, could be given to the workers, and Sir Patrick Hannon suggested the printing of a leaflet so that the substance of the reply could be distributed throughout the whole country. That is all the evidence that could be needed of the impression made on the House, first by Sir Andrew Duncan's able and convincing examination of the Report—printed in our issues of July 31st and August 7th—made by the Select Committee on National Expenditure; and secondly, by the remarkable facts about the work of the Government factories given by Mr. Assheton. The House, we believe, felt that much of the uneasiness experienced by the public, and much of the restlessness displayed by workers, would evaporate under the clear common sense of Sir Andrew's examination and would be replaced by confidence in the management of the factories and satisfaction with their achievements.

It is sometimes possible to detect on public platforms and in the House of Commons a certain measure of confusion between efficiency and output. For example, because a number of hours of work not exceeding sixty results in the greatest production per man-hour, it seems to be supposed that production will fall off if longer hours are worked. That conclusion by no means follows; production continues even when the most efficient limit has been exceeded, and where output is very important it may be necessary to sacrifice efficiency to attain it. That, *mutatis mutandis*, is what happened in the early days of the R.O. Factories. The main thing was to get them into being and get them to work; efficiency had perforce to be a secondary consideration. By degrees, as the organisation settled down, as workers learnt their jobs, and as new and better methods were introduced, efficiency increased—in the filling factories it has risen by 40 per cent.—and, if it were not for other considerations, there would be now too much capacity and too many workpeople. One other factor is flexibility and the ability to take a sudden load. Just as a power supply station must have standby plant to meet peak or unexpected demands, so must the Ordnance Factories have some reserve to draw on in an emergency. Hence it would not be good policy to attempt to restrict the size and equipment of the factories to the smallest figure. Furthermore, it must be remembered that the factories and the hostels for the workers were erected and equipped in an emergency when no one could make a really definite estimate of what the requirements would be. It is not quite just to measure the past by the improved conditions of the present. "In a growth so speedy and so big," said Sir Andrew Duncan, "there may well be many directions in which, now that the mechanism is in full working order, its operation can be consolidated into a better ordered whole. Even so, I ask the House to pause before applying the ordinary standards of criticism of administrative competence without some reservations, not too many, for the emergency conditions under which so much of this has had to be done."

On other pages we print Sir Andrew Duncan's speech almost in full. All who read it will have to acknowledge that it is an extremely able defence of the organisation and operation of the Royal Ordnance Factories. Taken in conjunction with Mr. Assheton's reply to the debate, it shows quite convincingly that the Factories are achieving a wonderful output, and that, after all, is the main thing. It is, perhaps, a matter for regret that, in Sir John Wardlaw-Milne's words, it would have been "out of order" for the Ministry of Supply to have discussed with the Select Committee the draft of its Report before publication. Could that have been done, it is possible—we say no more—that the Committee would have modified some of its criticism. Yet, as we implied in our review of it on July 31st, the Report embodies sound practice. Whilst the conditions necessitated departures from that practice the principles remain unaffected. It is satisfactory to know that in several, if not in all respects, they are being followed as the Royal Ordnance Factories—and particularly the filling factories—get into their stride. Finally, we must rejoice that the reply to the Report has been made so promptly upon its appearance. Thereby a good many misunderstandings may be removed. That desirable object will be attained more thoroughly if it be found possible to publish broadcast a pamphlet summarising the facts put before the House by Sir Andrew Duncan and Mr. Assheton.

Natural Resources and the Atlantic Charter

THE main purpose of the meeting of the British Association last month was to discuss mineral resources in the light of Clause IV of the Atlantic Charter. Thereby a start was made in that collection and classification of fact and opinion regarding the availability of such resources and the means that might be adopted to provide free access to them for all the nations of the world that will be necessary when the war is over. Underlying that discussion there was that other aspect of the subject, of growing importance, concerned with the eventual exhaustion at least of the richer and more accessible sources. In this present century, as was pointed out by speaker after speaker, there has been an expansion of production on a scale unprecedented in any previous age since the advent of man, so that mineral resources are now being drawn upon at a rate that increases year by year. Moreover, that increase seems likely to continue. As was stressed by Professor J. G. Smith, in his contribution on "International Trade in Raw Materials," the grand Victorian conception of a world in which a few developed countries imported raw materials from and exported manufactured goods to the other nations is fading before the hard logic of established facts. Even at the turn of the century there were significant signs of the coming change, and in the period "between the wars" many countries expected by the Victorians to remain predominantly agricultural began to develop manufacturing resources.

It is reasonable to suppose with Professor Smith that that tendency must continue and that after the war enormous areas heretofore backward will be developed. Russia, fortunately for us, had set about expansion on a great scale long before the opening of the present war. China, awakened by the aggression of Japan, seems likely to follow suit once the invader has been driven from her soil; and the South American States and the great Dominions of our own Commonwealth have already made a start. If such a worldwide development, already begun, is to continue, it is clear that in the post-war years even the present production records, inflated by the needs of war, are likely to be surpassed and the draught upon the mineral resources stored up for us by Nature be yet further magnified. The conference in its

discussions showed how the available deposits of minerals vary from huge inexhaustible stores, as in the case of those of aluminium, to the small uncertain stocks of rarer metals. Once drawn upon, those stocks cannot renew themselves in periods less than those reckoned moderate on the immense geological time scale. Sooner or later their exhaustion must be envisaged. But, despite the gloomy prophecies of the more pessimistic, that time does not yet appear to be pressing closely upon us. There are still, as in China, great areas of the earth incompletely explored for the rich stores they may hold; untouched, scarcely guessed at, resources lie beneath the seas, if we can but devise means to reach them; and for a distant time, when even the leaner lodes have been exhausted, there is the forerunner of a promise, in the developments described by Dr. Armstrong in his "Minerals, Old and New, from the Sea," that methods can be developed of extracting metals and other materials even when they are present only in minute proportions.

Yet, though we need scarcely fear for any real scarcity in the nearer future, it is mere wisdom on our part now to study how the best can be made of the resources laid down for us by Nature, so that our "capital" can be invested to the best advantage. At this point there enters into the discussion the important subject introduced to the conference by Sir Harold Hartley, in his paper on "The Recovery of Metals from Scrap." As he pointed out, scrap cannot provide the material for such new development as that of China requires. But it can to an extent that varies in accordance with the different uses to which metals are put provide in some degree for the replacement of structures and plant already installed. Already in America scrap is used in high proportions. In steel production it has reached a figure as high as 75 per cent., and for copper, lead, and aluminium it has reached 50, 45, and 35 per cent. respectively. As it becomes increasingly more difficult to win new ore from the earth, so is scrap, properly graded and collected, likely to assume growing importance. Thus Sir Harold's paper served to direct attention to a facet of the subject before the conference that must form an important part in any international discussions after the war on the implications of the Atlantic Charter.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

EDUCATION AND THE WAR EFFORT

SIR,—In our searchings of heart as to the causes of our inefficiency in running this war, two important factors seem to have been overlooked.

Forty or fifty years ago, when it was still no disgrace to have a large family, the placing of the boys in suitable careers was somewhat of a problem. At that time, as many older people can bear me out, the less intelligent boys in the family were put in (1) the Army, (2) the Church, (3) banking.

The boys of those days are now the people who are controlling these sections of the community, and it is surely more than a coincidence that they are notoriously those sections which have adapted themselves least to modern conditions.

The other factor lies in our education of those who are in control of the government of the country and the war effort.

In peacetime the running of the government of the country is almost entirely in the hands of the Civil Service, and the new departments constituted for war purposes have modelled themselves on Civil Service lines. The deficiencies of both are too well known to require enumeration.

The higher part of the Civil Service is almost entirely drawn from the universities and public schools, and the admission examinations are obviously designed to ensure a continuation of this practice. Much the same applies to the Army. This is perhaps not important except for two things, as it can be assumed that these sources are attended by the best brains in the country.

One of these things is the subjects which are taught at the public schools. The other—which, I am afraid, applies to all our schools—is the neglect of mental training in observation, logical reasoning and correct judgment, much more important mental qualities than memory, which is practically the only quality receiving mental training in any school.

It might have been quite reasonable 150 years ago to teach Latin and mathematics when it was possible for an intelligent man with a good memory to absorb most recorded learning which existed, but now, when in each of engineering, metallurgy, and industrial chemistry alone there is more new knowledge added every year than such a man could assimilate, and when the total accumulated knowledge is so great, it is of the utmost importance that only those subjects be used for mental training which will be of some value in modern life.

In the mental training experienced in its learning no language does materially more than develop the memory, and if it is considered that this particular training cannot be omitted, it is surely only sensible to teach a modern language. As for mathematics, the teaching of it is a waste of time. It is perhaps not generally realised how very few use advanced mathematics, and most persons are incapable of applying their knowledge even if they can retain it in their memory. Like poets, mathematicians are born, not made. It is a subject for the specialist.

To a lesser degree these observations apply to most other subjects taught at public schools, and the net result is that their products are turned out with a colossal ignorance of almost all on which modern life depends. The point of view of those responsible for this position is typically shown by the astonishing observation made by Mr. R. A. Butler, President of the Board of Education, at Harrow a few days ago, when he said, "if you have had a proper education in Latin you can, so to speak, take the internal combustion engine in your stride." It leaves one breathless.

We are very fond of saying that "this is an engineering age" and "this is an engineering war." If such statements are correct, the logical consequence is that the control should be placed in the hands of engineers; but where in this country can we see it done? Their advice is not even taken on matters which are their special province, and no attempt is made to give those running the country and the war even the most elementary knowledge of engineering. Is it any wonder, therefore, that we muddle and this time possibly not through.

F. O. L. CHORLTON, M.I. Mech. E.

Bury, August 7th.

CARGO AIRCRAFT

SIR,—The conclusions reached in your able leading article on July 31st on this subject are surprisingly different from those that must plainly have been reached by competent engineers on the other side of the Atlantic. If your argument is valid, the American action appears foolish. The question is which is right.

You suggest that it would be better to go on building surface ships rather than to release any of that building capacity for the construction of cargo aircraft. But since this argument makes no reference to the rate of sinking of surface vessels (which in the limit could make their building useless), it can have but limited validity. Moreover, account must be taken not only of the loss of the vessels and their cargoes, but of the gallant and valuable crews that man them. The U.S.A. decision may, I suggest, have given very high place to this last factor.

The air crossing (eastward laden and westward light) is easily done in a single "hop" and at night. Hence the risk of interception is slight and the losses should be exceedingly low. Moreover, the goods can be flown close to their destination and so save repeated handling. Hence the cargoes would be transferred vastly more rapidly—ten or even twenty times as fast as by the older route.

However, the question is not whether all east-borne traffic should go by air, but merely whether it is desirable to test the feasibility of sending some of it that way. We used, I believe, to import across the North Atlantic some 10,000,000 tons of goods per annum, of which an appreciable fraction was contributed no doubt by the 3,000,000 tons of water which, Sir Edward Appleton tells us, we used to bring in each year, before dehydrated food supplies were common.

It would certainly be a great help if we knew that even a million tons of this could be flown across rapidly as and when desired. If Mr. Kaiser's 500 new aircraft could manage to convey 2000 tons each per annum, this would be done. In that way we should have two strings to our bow, whether for transporting troops or goods, and feel much the happier in consequence.

If I wished to criticise Mr. Kaiser's proposal, it would be on other lines: to ask whether this amount of aircraft construction could not more usefully be employed as supplementary to the present anti-submarine equipment? But this alternative must have been fully considered already by the U.S.A. authorities, near whose coasts most of the recent sinkings are reported to have occurred. SQUADRON-LEADER.

August 10th.

REDUNDANT MACHINERY

SIR,—The letter in your issue of June 19th from Sir Alfred Herbert again stresses the deeper interest now rapidly growing in the future of constructive ideas.

Many "standards" must, as he suggests, be banished to the limbo of forgotten things, or, perhaps better still, remembered as mistakes for which a bitter price has been paid in destruction, death, and disablement.

What hope can be held out for the future of humanity so long as one works in order to live, and thereby "takes it out of our neighbours"?

An entirely new and wider conception of Government and especially finance must be evolved now, if disasters on a still more immense scale are to be averted, and engineers in particular given the inspiration to carry into effect

the great works which can and should be done in every part of the world on the cleaner basis of "living to work and create" and more—to work with that enthusiasm which only ideas and ideals can truly inspire. Not on the war-provoking basis of "What can I get out of it?" but rather "How much can I put into it?'

At the time of writing our thoughts are turned on the desert battle in Egypt and the Qattara Depression leaps to the mind as one of the many places which, we are informed, is largely below sea level, and into which I suggest the sea should be canalised, and the whole of that part of North Africa opened up to the entry of vessels and aircraft.

Many such areas in all parts of the world should be similarly developed, using the vast war factories and resources which now deal only in death and destruction of all that humanity holds dear.

It may be a shock to many of your readers to give a thought to the question, Which is the Department of State which is doing the greatest job of all? The Cinderella! The Post Office! Try to figure out the multitude of services rendered, not least by the Post Office engineers. A pattern on which to build the ideal State services in all its creative branches (and with which I have no personal connection), and when the time comes—as come it must, whether we like it or not—when the nation will control the railways, mines, and all public services, it is in the spirit of the men and women of that branch that the *morale* must emanate.

There appears so little difference between the coupons which now fill so much of our lives and the ledger coupon called a bank note that there can be no reason why services in the general interest of humanity cannot be "financed" by a form of dated issue vouchers of given values.

The very words "redundant machinery" apply most to our State methods. For what could possibly be more utterly crazy than one Department of State paying another Department for services out of Treasury Votes? The payment of salaries to Civil Servants, and then setting up expensive machinery to collect a percentage of it back, is sheer lunacy, since there can only be a deficit, meaning nothing, producing nothing, and destroying that *morale*, which is of far greater value than currency money.

These things are the redundant machinery, whereas the production machinery now producing only munitions of war can—in the hands of the engineers and keen-minded workers—be quickly adapted to produce useful engineering goods to rebuild the bridges, roads, railways, &c., and the housing of those who are to come after us.

W. Howard Coad.

Launceston, Cornwall, July 26th.

DIVING AIRCRAFT

Sir,—After so much prejudice has been lavished on the dive-bomber, it was encouraging to see an objective assessment of its qualities in your leading article "Diving Aircraft," on page 114 of your issue dated August 7th, 1942.

There is, however, one point I would like to ask you to reconsider. You say that "the striking velocity of the projectile is but half what it would have been had the bombs been dropped from altitude." That may in itself be correct, but it tends to overlie one of the effects of launching a bomb in a steep dive—the initial impulse given to the bomb along the aiming line. You estimate the diving speed of the German dive-bombers at 250 miles an hour. That would be more than one-third of the terminal velocity of a general-purpose bomb of conventional design when dropped from 40,000ft. or higher than any bombing aircraft are yet able to operate. There is, therefore, an appreciable increase in striking velocity conferred upon the bomb by the dive of the aircraft launching it.

May I try to sum up the essentials of the dive-bombing technique, a technique I began to develop experimentally as a pilot in 1918? I would say that by launching a bomb in a steep dive the bomb is given an initial impulse along the aiming line as opposed to level bombing when the bomb is given an initial impulse at a big angle to the aiming line. I would also say that the bomb can be launched at very close range (say, less than 1000 yards) and can yet be given a flight path which enables it to strike the ground almost vertically. (Those who have watched practice level bombing on ranges know that bombs dropped from aircraft flying low and level "bounce" for great distances, making accuracy of aim impossible.) Finally, there is the point I have made already that the direction of the dive imparts extra speed to the bomb along the line of aim, which is also the flight path of the aircraft and which approximates to the trajectory of the bomb after release.

Oliver Stewart,
Editor, *Aeronautics*.

London, W.C.2, August 9th.

Tapping Rubber Vines in South Africa

Every feasible means for producing rubber in the Union is being explored by the South African Government in its efforts to meet the existing shortage, and "Landolphia" vines, which grow in certain native areas, are to be tapped with this object in view. The Controller of Rubber has stated that as the result of a meeting with the Native Affairs Department, it has been decided to throw open the native territories to private enterprise. The Secretary of Native Affairs is calling for tenders for the right to tap the Landolphia vines. Tenderers, after supplying certain information, will appear before a committee. Major Stratford, the Controller of Rubber, while viewing the project with reserve at present, says there are some who are very optimistic about the Landolphia, which has a higher rubber content than the Euphorbia. "We are only on the threshold of the matter at present, but if people are going to apply for concessions, there are possibilities of its being exploited economically," he said. "I am encouraging it to the best of my ability, and in the course of a few months we may be able to add to our reserves of rubber."

Two of the staff of the Leather Research Institute, Graham's Town, have just described the investigation of the Euphorbia (Melkbos) as an alternative source of resin and rubber. The 193 species of the South African succulent Euphorbia have an amazing variety of habit, and some suitable kinds are found, especially around King William's Town, the coagulated latex of which contains about 80 per cent. resin and 16 per cent. caoutchouc. The former appears suitable as a substitute for imported synthetic resins used for the manufacture of paints and plastics. The rubber has been found to be of a lower grade than that from Hevea, and vulcanising has not yet proved too successful. It can be used for rubber soles. Every effort is being made to solve the various problems as soon as possible, with a special view to the production of tyres.

The use of rubber in the manufacture of thirty-one types of articles, including rubber floors, wrist straps, bath mats, universal joint discs for motor-cars, hockey stick rings, and all types of handle grips for sport accessories, is prohibited by regulations published on May 15th.

Information has just come from Natal that a sample of latex, obtained by a Durban engineer when he tapped a Euphorbia tirucalli tree growing in the Umgeni Valley recently, has been found to contain 12·92 per cent. of rubber, according to the analyst's report. Quickly following this came another statement from Durban, as follows:—"In connection with the report furnished yesterday of the analysis of a sample of latex tapped from a Euphorbia tirucalli tree in the Umgeni Valley, in which it was stated that the sample contained 12 per cent. rubber and 21·88 per cent. resin, the analyst points out that these figures referred to the uncoagulated latex. When this latex coagulated, he explained, there would be a yield of 26 per cent. rubber and 44 per cent. resin, which was the highest he had seen in this country." It is understood that great quantities of these trees are available, and, if so, and the results said to be obtained are confirmed by further investigations, then with the quantities known to exist elsewhere in the Union, a worth-while contribution could be made to the efforts being made to reduce the great shortage of rubber which exists in the Union as a result of the cessation, through war, of supplies from Malaya and other places in the Pacific.

Sixty Years Ago

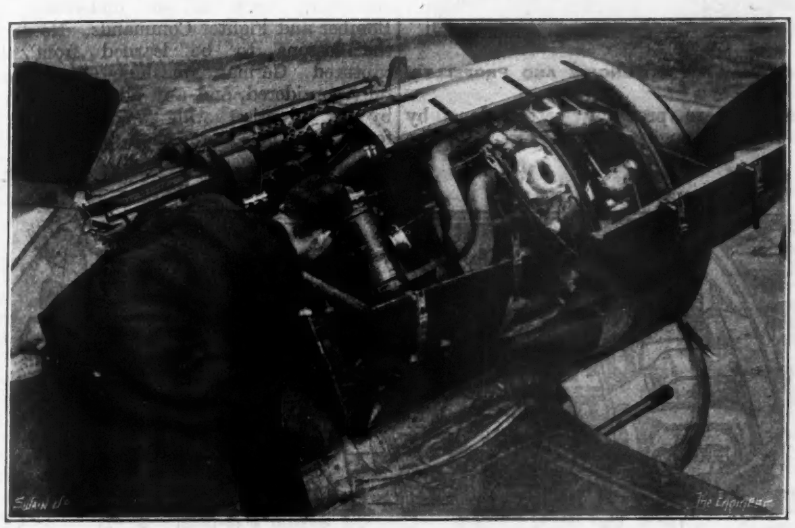
Our Guns at Alexandria

Following the bombardment of Alexandria, reports were published in the daily Press to the effect that some of the guns of the British ships present on that occasion had not behaved as well as they should have done. In our issue of August 18th, 1882, we recorded what we believed to be the truth of the matter. The reports chiefly concerned the guns of H.M.S. "Alexandra" and went so far as to say that they had been rendered unserviceable. The facts, we said, were that two of her 10in. guns had developed slight imperfections at the welds and exhibited a small movement of the coils, but the efficiency of the guns had in no way been affected and they were ready to continue their work if necessary. On the same ship one of the 11in. guns had been damaged by the bursting of a common shell in the bore near the muzzle. A slight crack was produced in the steel tube, but the gun continued to fire after the mishap. It was proposed to drill a hole at each end of the crack to prevent it from spreading, a procedure which, in our judgment, was not likely to prove satisfactory. Regarding our ammunition, reports had been published that some of our shells had failed to explode. In one instance, it was said, a shell from the "Inflexible's" 80-ton gun was found unexploded in the drawing-room of a house. On the owner's request that it might be removed it was carried carefully away, rolled up in a feather bed. This incident, we said, raised the question of the best means of dealing with unexploded projectiles fitted with percussion fuses. We thought that the best way would be to drill a hole in the shell casing—in the presence of a liberal supply of water—and then saturate the contents before attempting to move the shell. The subsequent disposal of the projectile raised another problem. We reported that one of our old shells fired at the siege of Sebastopol had recently exploded on being tampered with, and we recalled that iron shot brought up from the "Mary Rose" after lying 200 years under water was so finely honeycombed that on exposure to the air they steamed fiercely and became intensely hot. It was possible, therefore, that, two hundred years hence, the shell removed in the feather bed and dumped into the sea might be recovered and finish its career by exploding.

White Cement Floors.—Many of the new American war factories are built without windows, and in one aeroplane assembling shop several months' service with white cement floors have proved their worth in affording good lighting conditions. A scientifically conducted lighting survey, in which more than 300 measurements were made, gave results that considerably exceed those obtained on standard grey cement floors. In this plant, where both types of floor are used, the reflection factor for the white cement floor was 61 per cent. greater when the floors were new, and a recent check shows the white cement floor to have lost less reflecting value than the grey cement floor.

Focke-Wulf 190 Fighter

FOR close upon a year, our R.A.F. fighter pilots have been familiar with a new type of German single-seater fighter monoplane, having a radial engine and equipped with both machine guns and cannon. This new type of fighter aircraft has been met with in increasing numbers, but it is only in recent months that these new machines have ventured over the English Channel. A few weeks ago one of these new Focke-Wulf 190 fighters was intercepted over the Channel by R.A.F. machines and after a long combat it was finally forced down on the South Coast, short of both fuel and ammunition. When the aircraft landed, an armed patrol close at hand overpowered the German pilot before he could make good his efforts to destroy his machine. With only slight damage the captured fighter was found to be in good condition, and after careful dismantling it was reassembled by British airframe and engine experts, and after being painted in British colours was put through its paces by British pilots.



ENGINE OF THE FOCKE-WULF

Last week we were invited by the Ministry of Aircraft Production to inspect this new German fighter, both on the ground and under test flight conditions, and in what follows we give some account of its special design and performance.

Dimensions and Particulars

Span	34ft. 5in.
Length	29ft. 4in.
Gross weight	About 8500 lb.
Wing loading	42·3 lb. per sq. ft.
Type of engine	B.M.W. 801 radial
Number of cylinders	Fourteen in two banks
Speeds:	326 m.p.h. at 4500ft., supercharger in low gear; 375 m.p.h. at 18,000ft., supercharger in high gear
Rates of climb:	3050ft. per minute at 4000ft., supercharger in low gear; 3280ft. per minute at 17,500ft., supercharger in high gear
Armament:	Four 20 mm. Mauser cannon; two Oerlikon 7·92 mm. machine guns

The general outline of the aircraft is indicated in the accompanying engravings. It is clean in design and the stressed skin construction is well carried out, the fairing between the fuselage and the wings and tailplane being particularly good. The cockpit for the pilot is neat in design, and is closed by a sliding cover, with provision for jettisoning by firing an explosive cartridge. The cockpit is adequately armoured, a plate of about 14 mm. armour being arranged behind the head of the pilot in the sliding cover, and the seat being surrounded by a sheet of armour. The closing of the cover is done by means of a rack operated by a rotating handle with pierced index plate arranged on the right-hand side of the cockpit. The control instruments are very complete and, besides the more usual controls, there are adjustments for the rate of air flow to the lubricating oil coolers and to the engine cylinders, which enable the machine to be handled effectively even by an inexperienced pilot. The airscrew is of the three-bladed, constant-speed, metal type, with both hydraulic and electrical operation. Press-button controls for the setting of the wing flaps to fixed angles when manœuvring are provided. The gun and cannon firing controls are arranged at the top of the control column. A safety catch covers the button on the top of the column, and when thrown back leaves the trigger in firing position, while an additional lever enables the pilot to fire the machine guns or cannon separately, in groups, or all together. An interesting point in the general design is the arrangement whereby the air, after cooling the engine, is allowed to escape through slots in the engine casings at each side, so that a layer of fresh air flows along the skin of the machine and thus prevents any danger of the exhaust gases from the engine entering the cockpit. Cabin heating and also wing de-icing is provided and is effected by the use of special heating muffs built around the engine exhausts. The fuel tanks are built into the fuselage and carry 544 litres.

The retractable undercarriage works in conjunction with the retractable tail wheel. On each of the main landing wheel legs there is a simple loading indicator consisting of a scale painted on a static member, which moves alongside another scale attached to the oleo leg, and by this means a ready indication of the loading of the aircraft is given. Provision is made to carry a 250-kilo. bomb in a sling below the fuselage.

The arrangement of the machine guns and cannon will be seen from the views of the machine given. The two Oerlikon machine guns are grouped together over the top of the engine, and these, along with the two inboard cannon, have electrically operated interrupter gear, which allows them to fire through the airscrew disc. The ammunition drums are neatly accommodated in the spaces allotted, and in the case of the wing cannons are covered by a blister. One feature of the machine is the generous allowance of removable covers and cowlings, which gives ready access to the engine and the guns. The cowling clips are of specially neat design, the closing action automatically bringing the cover into position, after which it is locked by a turn of a screwdriver.

Engine Design and Arrangement

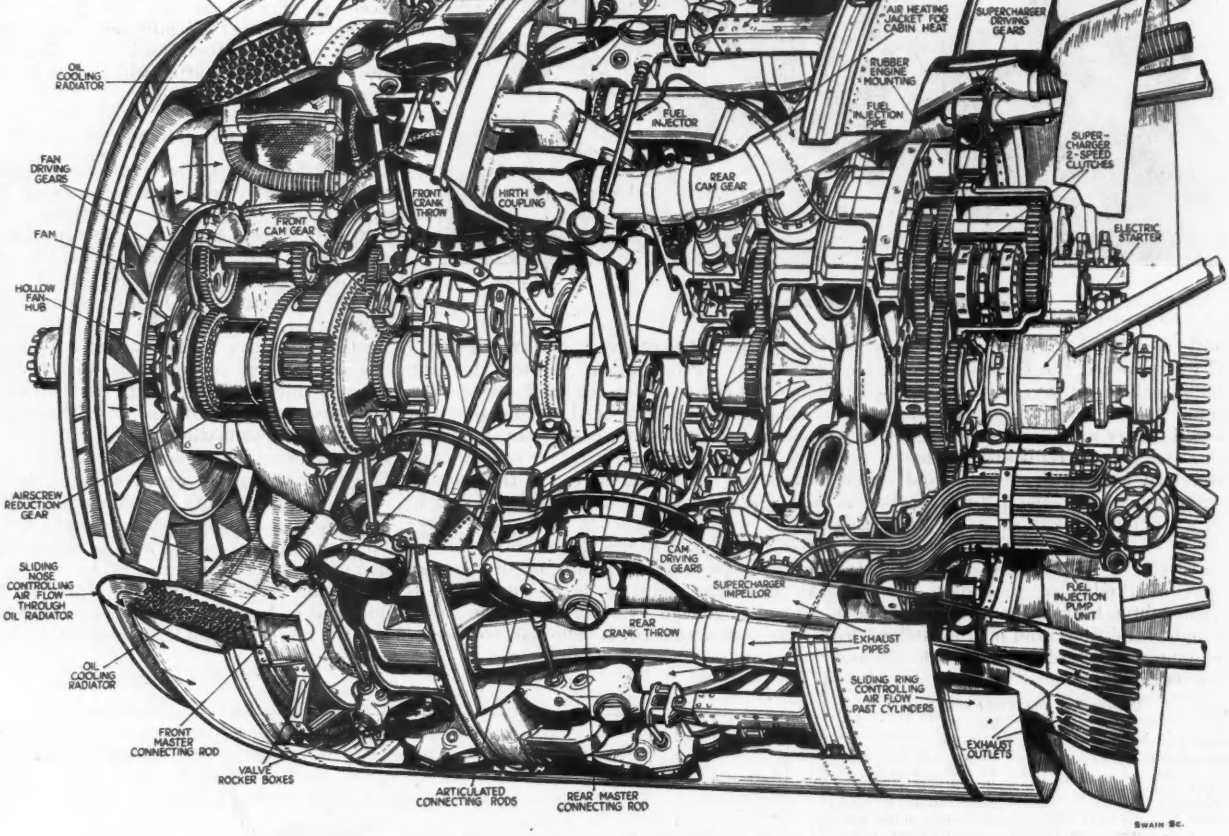
The performance of the new German fighter would not have been possible without the large engine power of something over 1600 B.H.P., which has been furnished in a very small space compressed within the outline of the fuselage body by the adoption of an interesting, if highly complicated, Bayerischen Motoren Werke Flugmotorenbau fourteen-cylinder, radial air-cooled engine. The arrangement of the engine with the airscrew reduction gear and its two-speed supercharger may be studied from the accompanying diagrammatic drawing executed by Mr. Max Millar for our contemporary journal, *Flight*, for the use of which we are indebted to Mr. Geoffrey Smith, its managing editor. This drawing appears in the current issue of our contemporary along with a full description of the aircraft and its engine.

As will be seen from the drawing, the problems of cooling the engine cylinders and also the lubricating oil have been solved in an

FOCKE-WULF 190 FIGHTER

ingenious manner. Behind the airscrew is a multi-bladed fan gear driven from the engine, which revolves within a sliding nose ring covering the oil cooler segments. The flow of air over the outer face of the nose ring passes over a space of about ¾in. between the ring and the oil cooler casing, and causes a suction effect, which entrains the air entering through the fan blades and reverses it so as to pass through the oil cooler tubes. By sliding the nose ring backwards or forwards the cooling effect can be increased or diminished as may be required. Between the fan and the engine the airscrew reduction gear is arranged. The fourteen cylinders of the engine are divided into a forward row of seven and an after row of seven cylinders, these two halves of the engine being joined by a Hirth coupling. In each bank of cylinders there is a master connecting-rod, with articulated connecting-rods for the other cylinders. The rocker gear is housed in neat boxes, and we noted the free use of light constructions, such as hollow nuts and other members. Between the engine cylinders there are baffle plates, which direct the air from the first bank of cylinders to the second bank. The engine is fitted with fuel injectors for petrol fuel and the connections from the injectors to the fuel injection pump unit at the inner end of the engine are clearly outlined in the drawing. Flow of air through the engine is controlled by the movement of a sliding ring, through which the exhaust outlets with their splayed ends pass. Other parts of the engine shown in the drawing include the cam driving gears, and the gear-driven supercharger with its two-speed clutches. At the back of the supercharger drive is the electric starter. As previously, some of the exhaust pipes are jacketed in order to provide for cabin heating and to furnish heat for wing de-icing. From the complicated design of the engine and its accessories it would appear that maintenance overhauls are probably better done by removing the engine from the aircraft. The engine we have briefly described, after our very short inspection, will be of interest to our aircraft engine designers, as providing one solution for effective engine cooling and its control, and the accommodation of a motor of high power in a comparatively small and confined space. The aircraft was designed by Ingenieur Kurt Tank, the chief designer of the Focke-Wulf Flugzeugbau Werke.

FRONTAL VIEW OF ENGINE AND PROPELLER



DIAGRAMMATIC DRAWING OF 1600 H.P. ENGINE OF FOCKE-WULF FIGHTER

Performance

The performance of the Focke-Wulf 190 fighter in the air showed its high speed and ease of manœuvring. The high wing loading adopted requires a long take-off and landing, and we were informed that, despite the use of a two-stage supercharger, the performance of the engine falls off rapidly above 20,000ft. The fuel tanks are, as regards capacity, rather on the small side, holding about 119 gallons. Owing to the high engine consumption at, say, an operational cruising speed of 310 m.p.h., this allows for a flight of slightly under one hour. When a period of full-throttle flying, such as would undoubtedly occur under fighting conditions, is allowed for, the flying time for the given fuel tank capacity must be correspondingly reduced, showing that, in spite of the high engine performance achieved, some disadvantages have had to be accepted. In general, the new Focke-Wulf may be regarded as a well-thought-out type of defensive fighter, but it is not an aircraft for offensive operations, such as are undertaken by Bomber and Fighter Commands. No doubt the lessons to be learned from this captured German machine have been fully considered, and any advantages given by its adoption will, we are sure, be found to be more than countered in the new British aircraft now under construction.

A New Brunswick Bridge.—A new bridge across the mouth of the Nipisiguit River, New Brunswick, has been completed recently and is now open to traffic. It consists of six creosote and six concrete spans having a granite foundation. The east end has a 75ft. stone embankment 12ft. high, and the west end has a 30ft. stone embankment about 6ft. high. *Engineering and Contract Record* records that before starting the construction of the new bridge it was necessary to move the large steel spans of the former one approximately 30ft.

British Association

No. III

(*Continued from page 113, August 7th*)

DOCTOR Desch was the Chairman for the morning session on July 25th, and opened proceedings with the following address.

NEW METALS AND NEW METHODS, BY DR. C. H. DESCH, F.R.S.

In the course of the conference held by the Association last autumn attention was drawn to the enormous increase in the production of the most important metals, the output doubling itself in quite a short period: twelve years for copper, seventeen for pig iron, eighteen for tin, and so on. Along with this quantitative growth the development of modern industry has brought with it remarkable qualitative changes, elements which until lately were curiosities of the laboratory rising into industrial importance. Aluminium, which seventy-five years ago had only been obtained in quantities of a few pounds, had a world production at the beginning of the war approaching a million tons, whilst its later development on both sides of the Atlantic has been on a very large scale. Aluminium is not one of the rare metals; it is, in fact, the most abundant of all metals in the earth's crust, but at present bauxite, a rich mineral of very local distribution, is alone used for its extraction. But elements of rare occurrence, such as tungsten, molybdenum, and vanadium, now occupy, in consequence of the ever-increasing demands of the engineering industries for materials of higher strength or other special properties, a key position out of all proportion to their abundance. This is largely due to the discovery that the properties of a metal may be profoundly altered by very small additions of another element, metal or non-metal.

The usefulness of the less common metals is, of course, not confined to small additions. The possible combinations of metals with one another are virtually infinite, and in spite of the vast amount of research and practical experience in this field there must be many valuable combinations as yet undiscovered.

A few of the rare metals find applications depending on their own peculiar properties. Thus tungsten, with its very high melting point of 3650 deg. Cent., has superseded all other materials for the filaments of electric lamps. The invention of the fountain pen called for an exceedingly hard and incorrodible substance for the tips of the gold nibs, and this was found in a native alloy of osmium and iridium. Tantalum has proved specially suitable for the spinnerets used in making artificial silk, rhodium and indium for depositing in thin layers on other metals for protection against corrosion and so on. The non-metal selenium is used in photo-electric cells. Further uses of this kind will present themselves as the properties of the less common elements are studied more completely.

The high melting point of some of the metals has led to research in two main directions. On the one hand, it has been necessary to devise means of making metals compact and strong without melting them, and, on the other, to develop new materials and new techniques for operations at temperatures higher than those in ordinary metallurgical furnaces. Tungsten cannot be melted in a container of any known refractory material. The powder obtained by reducing its oxide is therefore packed into the form of bars under pressure and heated electrically until the particles cohere, and is then hammered in a special way until its strength is sufficient to allow of it being forged or drawn into wire. The same process has been applied to other metals, and a new branch of technology, known as "powder metallurgy," has grown up.

The chief obstacle to chemical operations at very high temperatures, 1600 deg. Cent. or over, lies in the difficulty of finding materials for furnace construction and for containing vessels which are both strong and resistant to chemical attack at such temperatures. The ordinary fire-clays become soft and are attacked by slags. A few oxides, especially alumina, magnesia, thoria, and beryllia, meet several requirements in this field, but their refractory qualities are lessened by quite small proportions of impurity, and their preparation calls for special technique, which has been developed as a result of long research in the laboratory, but has as yet been little applied on a large scale. When such materials become available in quantity—and there is no difficulty in principle, although the procedure may be costly—we shall see important developments in chemistry and metallurgy at high temperatures. It is interesting to note that it is the oxides of some of the rare elements—thorium, beryllium, and zirconium—which have the highest softening points among the refractory materials, so that their importance will grow with the extension of high-temperature processes.

The substitution of one metal for another for particular purposes is not always due to inherent advantages, but is often a consequence of a policy of self-sufficiency adopted by an industrial country. This motive has been very prominent in recent years. It is natural that Germany, producing much aluminium but very little copper, should adopt the lighter metal for overhead electric power cables, but a similar replacement in the windings of motors and dynamos was purely due to conditions of blockade and could not be defended on other grounds. During the period of armament and of hostilities such substitutions have been very numerous, but the subject is too big to be entered upon here.

The substitution of one material for another is not, as a rule, a simple matter. Metals differ, not only in strength, but in elastic properties, and this difference has to be allowed for. It has been proposed to use alloys of aluminium in a large scale in shipbuilding, their use in small vessels having proved successful, whilst the particular alloys used, those with magnesium, are highly resistant to corrosion by sea water. In changing from steel to light alloy, however, it would not be enough to calculate the dimensions of each member to give a strength equal to that in a steel ship. The hull would float too high in the water, whilst problems of stiffness would arise from the very different elastic properties, and to build a successful vessel the design would have to be new from the beginning.

Three instances may be given of the substitution of an entirely new material for one of which the supplies have been found to be inadequate or too costly. Platinum, a metal of very local occurrence, has been largely replaced for chemical purposes, fused silica taking its place in the concentration of sulphuric acid, and iron oxide in various catalytic processes. On a larger scale, Chile nitrate, a product formed under quite exceptional climatic conditions and almost unique, is no longer indispensable as a fertiliser, the nitrogen compounds required for agriculture and explosives being obtained synthetically from the air. The third example is the introduction of plastics, resin-like substances which may be given the most varied properties. For many purposes they replace metals, and when reinforced by textile material or paper have a strength comparable with that of a metal. Transparent varieties replace glass and are far less brittle; other types take the place of porcelain and earthenware. The manufacture of plastics is one of the rapidly growing industries, and the uses of these new materials are continually being multiplied.

It must be realised that even such substitutions as these do not necessarily lessen our dependence on mineral resources, although the relative importance of different deposits may be altered. Nitrogen compounds are obtained by the use of electric power, which in some countries is derived from water, but in some of the most highly industrialised countries has to come from the combustion of coal. Many of the plastics are also derived from coal or petroleum, but, being organic compounds, there is always the possibility of producing them from vegetable matter, as, for instance, through the production of alcohol, through fermentation and its conversion into more complex compounds. Such a procedure would be in line with the policy mentioned at the September conference, of depending on current revenue, derived from plants, rather than drawing unnecessarily on mineral capital, which once exhausted is not replaced.

Much might be said of means of economising metals—the use of structures built up by welding in place of heavy castings; the combination of concrete with steel in buildings and bridges; the saving of valuable metals by employing them as thin coatings on mild steel in chemical plant, and so on, but time does not permit. As new materials come into use and new techniques are developed, while at the same time the known reserves of some indispensable metals are being depleted, it becomes clear that the efficient use of the world's mineral resources demands systematic planning. First of all, a far more thorough world survey is needed, gathering together the information collected by prospectors in the interest of large industrial corporations as well as by the various national surveys. This survey would form the basis of a system of international control, and it is to be hoped that suggestions as to how this may come about will be one of the results of this conference.

THE RECOVERY OF METALS FROM SCRAP, BY SIR HAROLD HARTLEY, C.B.E., F.R.S.

The dominant feature of industrial development in the nineteenth century was the use of power, but closely associated with it and of hardly less importance was the enormous increase in the use of metals made possible by metallurgical progress. In 1800, for instance, the world production of iron and steel was about half a million tons, in 1900 it was 40 million tons, and now is over three times as great. This rapid growth in the use of metals made serious inroads into the world reserves of ores, and in some countries the available resources, particularly of the richest ores, were exhausted or seriously depleted, so that the problem of conservation has become urgent, and with this lies a close connection with the question of the ultimate fate of metals in use and their recovery as scrap. To what extent are they lost in use? Do they, in fact, follow man-made cycles, like the well-known carbon and nitrogen cycles in Nature, so that the world stock is not in fact depleted? An exact study of the fate of the industrial metals is impossible owing to the lack of accurate statistics, and to the uncertainty as to their secondary uses, but it is clear that in this century scrap is playing an increasingly large part in metal production and must enter into any comprehensive survey of world metal supplies in the future. In the United States, for example, it is estimated that in recent years ferrous scrap has amounted to 75 per cent. of the output of steel, while non-ferrous scrap has accounted for 50, 45, and 35 per cent. of the total domestic consumption in all forms of copper, lead, and aluminium respectively.

The word "scrap" is used in this paper in the sense usually understood here to cover what are often described as secondary, reclaimed, or run-around metals. Obviously there are different types of scrap which may be defined to indicate their origin as:—

(1) *Process Scrap.*—Scrap arising in the production of a finished or semi-finished article which is re-used in the plants of origin. This includes ingot heads, gates and risers from castings, crop ends of rolled material, trimmings from sheets, tubes, &c., all of which are normally returned to the melting furnaces in the same works.

(2) *Engineering Scrap.*—Scrap such as swarf, drillings, turnings, and rejects produced in

engineering shops which are usually separated from the primary production, so that this scrap cannot be so quickly absorbed. Further, its physical character and high degree of oxidation often make it difficult to use in re-melting furnaces.

(3) *Old Scrap.*—This consists of disused material arising from obsolescence, accident, and worn-out parts. Recovery of this is a skilled trade, involving the breaking up of machinery into its component scrap categories, *e.g.*, a motor-car is stated to contain no less than twenty-five different ferrous alloys and the same number of non-ferrous alloys.

The disposal of scrap metals and their use to the best advantage is becoming more complicated each year owing to the increasing use of alloys. The whole problem would be vastly simpler if metals were used mainly in a pure state or admixed in the case of iron with carbon alone. In many cases, *e.g.*, bearing metals and tool steels, the alloys are kept separately in the process of collection, for re-use after re-melting and adjustment of their composition, as the recovery of the constituent metals from their alloys would be a wasteful and often a difficult and uneconomical operation. The sorting and classification of scrap is therefore a matter of great importance. For process scrap it is an easy matter, as this goes straight back to its own melting furnace. For engineering scrap the segregation is relatively easy if it is properly organised in each works, but the scientific sorting of old scrap presents much greater difficulties and requires careful organisation to avoid waste. The higher prices paid for special alloys is an incentive to make the sorting as effective as possible. However, this is not so easy with small admixtures of alloy metals, and increasing difficulties are arising from the presence of these in undesirable quantities in the recovered metal.

The volume of consumption at any moment depends on new demands and on replacements due to obsolescence, corrosion, and wear and tear. It is therefore clear that unless there should be heavy accumulations of scrap or new demands had vanished in a severe depression, the amount of scrap arising for replacements must always be less than the total amounts of metal required for current production. The relation between the two will vary with the metal and the circumstances.

With the modern tendency to rapid development and quicker obsolescence, the life cycle of metals will in general be shortened. On the other hand, welding has made possible the repair of steel, *e.g.*, at rail ends and in locomotive fireboxes, which will increase the service life of metals. The development of improved materials with increased hardness, greater resistance to wear and fatigue, and to corrosion (including painting and surface treatment) also tends to lengthen the life cycle and eliminate losses of metal. The use of lighter designs, the increasing use of sheet metal and of a multiplicity of small gadgets may, however, tend to make scrap recovery less complete.

An interesting point arises in connection with the increased use of reinforced concrete in place of steel construction; this effects a considerable saving of steel amounting to 50 or 60 per cent.; but, on the other hand, it is not economical to recover much of the steel in reinforced concrete, while the bulk of a steel frame can be salvaged.

For iron and steel, corrosion is the biggest factor, which Speller estimates may lead to an annual replacement of 2 per cent. of the total tonnage in use.

The absence of world statistics on the recovery of scrap makes it impossible to give a comprehensive picture of its full significance. However, it is clear that scrap recovery will be of increasing importance as regards the conservation of our metal resources, and that as a major source of raw materials it must be brought into any general scheme affecting them under the Atlantic Charter.

Taking conservation first, the following measures would help towards a maximum scrap recovery and help to diminish wastage of metals:—

(1) The salvage of all new and as much old scrap as possible.

(2) Improved methods for segregating engineering scrap of different kinds so as to avoid mixing different metals and alloys.

(3) Improved methods for sorting and cleaning old scrap and identifying doubtful material by quick tests.

(4) Improved methods for cleaning scrap and putting it into a suitable form for re-melting.

(5) Arrangements to avoid losses by corrosion when scrap, often finely divided, is kept for long periods.

(6) Avoidance of the unnecessary use of alloys, which complicates scrap recovery, and the reduction of the number of alloy specifications to the minimum necessary.

(7) Improved methods for protecting metals against corrosion.

(8) The re-use of old scrap by fabrication and welding.

In any general scheme for metal supplies under the Atlantic Charter the first essential is the compilation of international statistics on an agreed basis. Even if these cannot be complete owing to the difficulty of including old scrap which is re-used by works internally and so-called run-around scrap, such as bearing metal, which circulates internally and therefore does not come into account, it should be possible to collect data for all process scrap, engineering scrap, or old scrap which reaches the market, so as to see to what extent consumption in each country can be met from virgin metal or from scrap. The need for such statistics was emphasised in the following passage from the report of the National Resources Board of the United States appointed by President Roosevelt in 1934:—

> "The subject of scrap is the great blind spot of the world's metal economy. Despite the importance of secondary metals, no statistics of an international character can be had. The United States is the only Government compiling figures of secondary metal production. The present annual statistics of the Bureau of Mines should be established on a quarterly or monthly basis and expanded to include stocks and consumption as well as output. This is one of the most constructive steps that could be taken for stabilisation of the metal industries. Until the importance of scrap is recognised, effective adjustment of supply and demand in the metal industries will remain difficult or impossible."

This was written in 1935 with special reference to the United States; to-day, in the light of the Atlantic Charter, it has a much wider significance.

Minerals, Old and New, from the Sea, by Dr. E. F. Armstrong, F.R.S.

In the past, but for one constituent—common salt—sea water has never been regarded as a source of raw materials for industry. To-day, three other essential substances, potash, bromine, and magnesium salts, are being extracted in considerable quantity from the sea by methods which are both novel and interesting. Such methods open up an avenue to the winning of other even scarcer but coveted minerals.

The composition of the ocean varies considerably in different places and at different depths. The salinity expressed as total salts per 1000 parts of sea water varies from a minimum in the southern part of the Indian Ocean, 33·01 parts, to a maximum from the middle of the North Atlantic, 37·37 parts. In the Dead Sea the concentration 300 m. below the surface is several times that at the surface. In hot countries the sea is led into basins and allowed to evaporate in the heat of the sun until first the calcium sulphate and then the salt crystallises; the salt is impure, but suffices. The bittern or residue is of no commercial value, though it has been further treated to obtain potash in an Italian Colony.

The exploitation of any particular source of a mineral is determined by economic considerations. Bromine affords a good example; so long as the demand for it was relatively small the Strassfurt monopoly maintained it at a high price. When it was required in very large amounts to make "ethyl" other cheaper sources had to be found. One of these is the Dead Sea, which is a half evaporated inland sea situated in a climate where there is more evaporation than precipitation. As the concentration of salts at the bottom of the lake is greater than that at the surface, the solution is pumped from depth, concentrated, and processed to obtain potash salts and bromine, thus affording a British Empire source of these minerals. There are similar inland lakes in the United States.

The Americans went to the sea itself for their bromine, having devised a simple method to extract the traces of bromine from very large quantities of water. At first they fitted up a ship as a floating chemical factory so as to ensure new water all the time. Later, the factory was put on land, the effluent water being run to the other side of an isthmus so that it never mixes with the untreated incoming water.

It requires 4000 gallons of sea water to yield a pound of bromine, so that a factory making only 50 million pounds, *i.e.*, 25,000 thousand tons, a year has to pump a great deal of the sea through its apparatus. The sea water is made of a particular acidity, the right amount of chlorine gas added and the free bromine so liberated is blown out by a stream of air counter current to the water which is falling down high towers with wooden packing. It is absorbed in soda solution, forming bromides and bromates. The process is continuous and automatic and under instrumental control; it is one of the triumphs of modern chemical engineering design and construction.

Though in practice the recovery of magnesium metal from sea water involves comparatively simple operations, it is far from being an easy task economically to utilise a raw material which contains about 1 part of magnesium in 800 of water. Quite unusual chemical engineering methods, equipment, and control have to be invented.

At the most successful and largest plant use is made of milk of lime, made from large deposits of fossil oyster shells found in the vicinity, to precipitate magnesium hydroxide from sea water which has been freed from extraneous matter. The hydroxide is collected in special filters and converted into magnesium chloride, using for this operation a 10 per cent. aqueous solution of hydrochloric acid which is largely derived from a latter stage of the operation. The magnesium chloride is evaporated and dried until anhydrous, when it is electrolysed in suitable cells to produce metallic magnesium; hydrogen chloride is evolved from the cells. Natural gas is used as a source of power; the effluent water is discharged 7 miles from the intake into a current of sea water which is always in the same direction.

Such, in a paragraph, is a description of a factory which is full of new methods and devices.

Magnesium, the lightest of metals, cost a sovereign a pound in 1915 and barely a shilling last year. It is expected that the capacity of a single sea water plant will be increased to 100,000 tons of metal by the end of this year, which represents an incredible number of gallons of sea water.

At the same factory, though in a separate plant, bromine is being extracted and the acid effluent from this mingles with the alkaline effluent from the magnesium to make a largely neutral return flow to the sea.

Magnesite made from sea water is proving a useful raw material for refractories. If calcined dolomite, a domestic British mineral, is used instead of milk of lime to precipitate the magnesium from sea water a double purpose is served and additional magnesium hydroxide obtained.

The advantage of the sea as a source of minerals is that there is free access to it for any country which has a coastline. Its use, therefore, comes under the Fourth Clause of the Atlantic Charter. The knowledge of its constituents and its exploitation in the service of man depends upon the progress of scientific inquiry.

(To be continued)

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

De-tinning in the United States

The question of obtaining quantities of tin by the de-tinning process has received considerable attention since the Far Eastern sources of supply were overrun by the Japanese, and in the United States hopes were expressed that the process would be used on a large scale. According to American reports, however, the attempt hitherto made has not been altogether successful. Recently the Chairman of the New York Salvage Committee stated that 5325 tons of used tin-coated containers had been collected in New York City since the salvage campaign opened early in March. The American Metal Market states that of this quantity, only 20 per cent. had been washed and prepared and, as the de-tinning plants are only equipped to handle clean tinplate scrap, the greater part of the salvage was not suitable for treatment. Nevertheless, the salvage drive has been extended to thirty-six other cities in the United States. During 1941 de-tinning companies treated about 340,000 tons of material, almost all of which was in the form of new tinplate scrap and clippings. The restrictions of the use of tinplate and the substitution of plain black plate resulted in a falling-off in the supply of tinplate clippings, and it is suggested that the excess de-tinning capacity can be employed to treat the cans. It will be necessary, however, for the American public to clean and put all old cans into shape for convenient transportation, by removing the tops and bottoms and flattening the cans. In wartime the transportation of cans over long distances is wasteful of wagon space. At the end of May the financing of five Government de-tinning plants and subsidiary plants for cleaning cans was approved. These are to be designed to treat more than 200,000 tons of salvage per annum. It is anticipated, however, that a scheme, which embraces plants capable of dealing with from 20,000 to 60,000 tons per annum, will not be ready for operation in less than a year. From these plants it is thought that 2000 tons of tin a year can be obtained. It is stated, however, that in the near future many cans will be manufactured from electrolytic tinplate, which will only have 0·5 lb. per base box coating, as compared with 1·25 lb. to 1·5 lb. on the hot-dipped products. It has to be proved, also, whether it will be possible to collect sufficient containers to work the plants to capacity.

The Pig Iron Market

The British pig iron situation is not unsatisfactory, although in some departments there is a definite tightness. The difficulties, however, are realised by the Iron and Steel Control, and their efforts to ease the situation to the war industries have been largely successful. The stringency is principally noticeable in the hematite pig iron department, but this has been a feature of the market for several months. Production has been pressed to the utmost and, in addition, the Control, by encouraging and stimulating the use of other descriptions of pig iron as substitutes, has helped the industry over a rather difficult period. Many consumers who before the war would have been reluctant to use anything but hematite for certain classes of work now find that satisfactory results can be obtained by the use of refined pig iron and low-phosphoric pig iron. It is possible that the extended use of this latter pig iron may be continued under more normal conditions and that necessary war methods will be carried on in peacetime. It is possible, therefore, that permanent changes in practice will result in some branches of the trade from the necessities which have been forced upon consumers by the war. The demand for high-phosphoric foundry iron has increased considerably during the past twelve months, but it is not sufficient to absorb the whole production and there are reports that stocks exist at some of the Midland furnaces. Poor consumption of this class of pig iron by the light castings foundries is the chief reason, and this is a factor in the position which is likely to last for the duration of the war. Lately there has been a considerable increase in the demand for refined pig iron, and delivery dates have become rather more extended. In low-phosphoric pig iron also the position has become rather tight. Basic steel production is on a high scale and, heavy as are the requirements of the steel works, these are being met with regularity.

The Midlands and South Wales

Activity at the Midland iron and steel works is increasing as the year progresses, and the holiday stoppages and the overhaul of plants which then took place appear to have enabled outputs to be increased. The re-rolling works in the Midlands have been well employed for some time on the production of light sections and bars, and with raw materials available on a satisfactory scale there is no reason to anticipate any decline in the rate of operations. The home production of billets is barely sufficient to meet consumers' heavy requirements, but stocks still exist in the country and recently imports have increased so that the position is now better than it was a short time ago. The steel works are fully engaged in all departments and lately the demand for heavy joists and sections has improved as a result of some important contracts which have been placed with constructional engineers. The demand for shipbuilding sections is maintained and large tonnages continue to pass to the yards. In other respects the situation is not greatly altered from that ruling in the second quarter of the year. The requirements of armament makers and aircraft manufacturers of special and alloy steels appear to be ever-expanding. Great efforts have been made to increase production, and as the distribution of this steel is carefully supervised the requirements of the consuming industries are fully met. The demand for colliery steel, which has been on a heavy scale for some time, owing to the scarcity of wood, shows no signs of decreasing, but the manufacturers of arches, roofing bars and props are meeting the situation and large tonnages are being taken up by the mining managements. The iron and steel situation in South Wales may be regarded as fairly satisfactory and, on the whole, regular deliveries have been maintained. The greater part of the South Wales production is devoted to the requirements of the war industries, and practically all departments are busy. Most of the steel works could take on additional orders for structural materials, although lately the situation has improved and consumers' requirements of heavy joists and sections have considerably increased. The firms producing billets are kept working at capacity, but the demand for sheet and tinplate bars has declined somewhat owing to the restrictions on the manufacture and use of tinplate. Consumers of tinplates appear to be growing more accustomed to the use of substitutes, but the demand cannot be described as active.

Scotland and the North

The Scottish iron and steel works are now operating under as heavy pressure as was the case before the holiday breaks. The most noticeable feature of the market is still the demand for ship, tank, and boiler plates, and, in spite of efforts to ease the situation, delivery dates are inclined to lengthen. All the works producing steel plates are fully employed and so far as can be seen are likely to remain in this condition for an indefinite period. Whilst there has been an improvement in the demand for heavy joists and sections, it still leaves something to be desired, and most of the works are in a position to give fairly early delivery. The Scottish engineering industry is almost entirely upon war work, and its requirements of steel in various forms are very heavy. The demand for steel bars shows no signs of relaxing and large tonnages continue to pass to the consuming works. The re-rollers report satisfactory supplies of semis, but some of the firms could deal with a larger volume of orders than has reached them lately. Small bars and sections, however, are wanted in large tonnages, whilst there is a steady business passing in reinforcing rods. The tube industry has been busy for a long time and the works have good orders in hand for pipes. The mining industry is absorbing large quantities of steel in colliery equipment. The Scottish ironworks are well employed and are receiving good supplies of the better qualities only, and a restricted business is passing in No. 3 and No. 4 descriptions. Holidays at the consuming works have led to suspension of deliveries from the iron and steel works in Lancashire and are likely to do so for the next week or two; but cancellations of deliveries have not been serious. The demand for semi-finished steel is on a heavy scale and there is a continuous and brisk call for wire rods. The production of steel wire is maintained, but is barely sufficient to meet the consumers' heavy needs. Great activity rules at the forges, which has resulted in a big demand for blooms and some other semis. Business in steel bars is at a high level. The demand covers practically all descriptions and consumers do not always find it easy to obtain early delivery. There is a steady call for colliery steel, which, however, has been adequately met by the producers. On the North-West Coast the steel plants are actively engaged and there is a large tonnage of orders in hand.

The North-East Coast and Yorkshire

There has been no relaxation in the intense pressure for supplies to meet the demand of the war industries. All the iron and steel plant on the North-East Coast is practically in continuous operation. It is expected that to meet the accelerated war production consumers' requirements in the last quarter of the year will exceed the heavy demand in the first part. Lately the constructional engineers have booked some heavy contracts and these have been reflected in an improvement in the demand for heavy joists and sections, and most of the works producing this class of material have booked sufficient business to keep them employed for the rest of Period III. There has been no decline in the heavy request for plates. This demand arises from the busy conditions which rule at the shipyards, whilst there has been a renewed call from locomotive builders and tank makers. Re-rolling works are fairly busy and the demand for light structural material, which has been active for some months, shows signs of expanding. There is a strong call for small bars, but business in ferro-concrete bars is not coming forward in such volume as a few weeks ago. The billet position, however, is satisfactory and the re-rollers are obtaining full supplies of this material as well as of blooms and sheet bars and, with the encouragement of the Iron and Steel Control, are using considerable quantities of defectives. Holiday breaks in Yorkshire have had comparatively small effect upon iron and steel production owing to careful planning. The breaks, however, were necessary, if only for the overhaul of plant which had been working continuously for a long time. The insistent demand for basic steel continues unchecked, whilst there is an increasing request for acid carbon steel. Great attention is being paid to the expansion of alloy steels, the demand for which increases more rapidly than the output. The measures which have been taken to ease the high-speed steel situation have proved satisfactory.

Copper, Tin, Lead and Spelter

The huge consumption of copper in Great Britain is being fully met by the Non-ferrous Metal Control, and there are no reports of any firm employed upon war work having to go short of its full requirements. On the other hand, there is no margin, after the war industries have been supplied, for meeting civilian needs. No doubt there is accumulating a considerable reserve of commercial requirements, which no attempt can be made to satisfy until after the war. In the last war somewhat similar conditions developed in more than one industry, but when the time came anticipations of an enormous outlet being provided by the need for meeting civilian necessities proved in many cases a fallacy, and civilians who had for a long time gone without found that their requirements were not so pressing as they thought and continued their policy of economy. This was partly responsible for the slump that followed the last war, and there are those who fear that trade may pursue a similar course when the present war is over. At present, however, the attention of industry is concentrated upon the production of armaments and munitions, for which copper is required in abundance. So far as is known, arrivals of copper in this country are regular and sufficient to fill the wartime requirements of the country.... The widespread efforts to economise in the use of tin are having their effect, and scarcely a week passes but a new method of conserving the use of the metal is announced. At the same time, attempts to stimulate production appear to have been successful to a certain extent, and supplies to firms engaged in war work appear to be regular and satisfactory. An interesting announcement has been made that the Department of Mines in British Columbia is intensifying the search for tin in that province. On the other hand, the Bolivian exports of tin in May showed a decline when compared with May, 1941, and April, 1942. The figures for this year were 2864 tons, compared with 3244 tons in April and 3587 tons in May the previous year. ... No development of importance has occurred in the lead position in Great Britain, and it is understood that considerable reserves have been accumulated in this country. It is probable that an increase in the production of lead pipes will be required, and that larger tonnages may be allocated to this purpose. These requirements, however, are likely to arise for special reasons, and it is unlikely that more lead pipe will be available for commercial purposes.... Steps which have been taken to economise in the use of spelter have been to a great extent successful, but spelter is now practically unavailable except for war purposes.

Notes and Memoranda

Rail and Road

S.R. "Merchant Navy" Locomotives.—Two more "Merchant Navy" class mixed-traffic locomotives were recently named by the Southern Railway. They are the "Shaw Savill" and "Aberdeen and Commonwealth." The naming ceremony was performed by Lord Essendon.

American Ore Transport Record.—A record in the number of freight cars loaded with iron ore and all other ores was established by American railways in the week ended June 6th, according to the Association of American Railroads, the total for the week being 92,453 cars. The previous record was established in the week of July 14th, 1923, when the number of cars loaded with ore totalled 89,087.

Seaboard Air Line Collision.—Eight passengers were killed and eight passengers and two employees were injured in a rear-end collision on the main line of the Seaboard Air Line shortly after midnight on June 14th. All the passenger casualties were in the observation car of the south-bound "Silver Meteor," which had been stopped for orders at Kittrel, N.C., 36 miles north of Raleigh, where it was struck by a following freight train.

Oil from New Brunswick.—Work has started on 10,000ft. of diamond drilling in the oil shale areas of Albert County, New Brunswick. The work is being done under a co-operative agreement between the Federal Government and the Provincial Government of New Brunswick, following the Oil Controller's recommendation that all possible sources of new oil supplies in Canada should be investigated and put into operation if possible. The Federal Government has set up a field laboratory at the scene.

Promontory Point Branch Line.—The Southern Pacific and Central Pacific Railroads are considering the dismantling of the Promontory Point branch in Northern Utah. *Railway Age* records that the line is the part of the original Central Pacific line which figured in the driving of the golden spike at Promontory Point, Utah, on May 10th, 1869, linking that line with the Union Pacific to form the first railway to the Pacific Coast. It extends from Lucin, Utah, to Corinne, a distance of approximately 120 miles.

The Alaska Road Route.—There has been, for some months past, a controversy over the proposed highway through Canada to the Alaskan seaboard. A sub-committee of the United States Senate Foreign Relations Committee has now decided unanimously not to recommend a full-scale investigation of the reasons why the Army chose a route running east of the Rockies. The chairman of the sub-committee has announced, however, that it would recommend the construction of a highway along the sea coast when peace is restored.

Air and Water

Plywood Lifeboats.—The United States Maritime Commission has placed a contract for 1000 lifeboats for Liberty ships, to be made from plywood. These boats, the first of the kind to be built, are to be 22ft. long and many of them will be self-propelled. Each of them will carry twenty-five persons.

American Aid for Australia.—At least 100 military aerodromes have been built in Australia, thousands of miles of strategic roads have been built or improved and 11,500 separate projects are now under way in a programme of construction by the Allied Works Council and the United States Army Engineer Corps. One large aerodrome, costing nearly £2,000,000, was built in seventy-one days.'

New Air Services.—An air service has been started between the U.S.A. and Great Britain by the American Export Air Lines, a company associated with shipping interests, and a competitor of Pan American Airways, Inc. The last-named has begun flights from Natal, in the Brazilian State of Rio Grande do Norte, to points on the African coast. Stops are made at Bathurst, in Gambia; Lagos, in Nigeria; and Leopoldville, in the Belgian Congo.

Moore-McCormack Cargo Ships.—During the last three months, six "C-1" type cargo ships, building for Moore-McCormack Lines in co-operation with the United States War Shipping Administration, have been launched. They are the "Mormactern," "Mormachawk," "Mormacwren," "Mormacdove," "Mormacgull," and "Mormaclark," and have a speed of about 15 knots. The ships are 417ft. long, 60ft. broad, with a depth of 37ft. and a deadweight capacity of 9400 tons. According to *The Journal of Commerce*, the ships are intended for the Scandinavian and Russian services of the Moore-McCormack Lines after the war, but for the present will be used in various services by the War Shipping Administration.

The Saimaa Canal.—Recent reports indicate that the Saimaa Canal, which links Lake Saimaa with Viipuri Bay, in the Gulf of Finland, is being widened to admit 1300-ton barges. This canal was constructed more than eighty years ago for 300-ton barges. It passes through a forest district with some industries and originally had eighty-eight locks.

A Steel and Timber Fitting Shop.—An interesting experiment in structural engineering has just been completed at St. Johns, New Brunswick. In order to save steel, the fitting shop in a new shipyard—the span is 78ft.—has been erected with a steel frame up to the level of the overhead crane rail and a roof structure entirely of wood. Crane rails and their steel supports project beyond the roofed area so that the cranes can pick up materials stored outside the building.

Miscellanea

Pipe Line in Ontario.—Work has started at Sarnia, Ontario, on the construction of a pipe line to connect the new gas purification plant of the Union Gas Company with the company's high-pressure transmission system.

Refractories Control.—The Ministry of Supply has announced that fire-clay and silica refractories are now controlled as part of the Chrome Ore, Magnesite, Wolfram, and Foundry Bonding Materials Control under the Ministry. Mr. H. Halliday has joined the Control as Director in charge of these materials.

A Successful Registration.—The Canadian Wartime Bureau of Technical Personnel estimates that there are 25,000 engineers and scientists in Canada, and it has complete information on 22,000 of them in its files. The 22,000 completed questionnaires constitute the most complete record ever compiled of Canada's technical man power. Greatest shortage is in research scientists, of which Canada has only about 2500.

Salvage from the Farm.—The International Harvester Company of America has collected 1,367,000 net tons of scrap metal in three months from farms and small towns in a country-wide campaign sponsored by the company and carried on through its 8500 farm equipment dealers. In most towns the collection was made a community project, with many organisations co-operating. No profits were made by either the Harvester Company or its implement sellers.

Liquid Fuel Reduction.—The Petroleum Board has been instructed by the Government to reduce supplies of liquid fuel, other than paraffin or petrol, used for central heating and domestic purposes. Every effort will be made to apportion reduced supplies equitably among the users of liquid fuel, and the Petroleum Board will communicate shortly with the consumers affected. Consumers should not attempt to transfer to other fuels, such as coal, coke, gas, electricity, as these fuels will not be made available to replace liquid fuel.

The Essential Work Order.—The Minister of Labour and National Service has made a new Order consolidating the existing General Provisions Order, the Amendment Order by which absenteeism and persistent lateness were made direct offences, and the Part-time Workers' Exclusion Orders which excluded from the principal Order part-time workers who had entered industry because of war-time conditions. In addition to certain minor amendments of an administrative nature, the new Order, known as the Essential Work (General Provisons) (No. 2) Order, provides that wages paid for overtime or Sunday work shall be reckoned as if paid for at the ordinary time rate in calculating a worker's wages to determine any payment necessary to make up the guaranteed wage payable under the Order. Another new provision secures that workers are not disentitled to the guaranteed wage in respect of time spent in attending Appeal Board hearings when they appeal successfully against suspension or dismissal for serious misconduct. Also, the existing provision that the guaranteed wage is payable during the interval between dismissal for serious misconduct and reinstatement after successful appeal is now extended so that a worker is not disentitled to the guaranteed wage if he takes temporary employment in the interval. Any sums earned in respect of the temporary employment are to be deducted from the guaranteed wage payable by the original employer. These amendments have been made in agreement with the Joint Consultative Committee of the British Employers' Confederation and the Trades Union Congress.

Canadian Metal Search.—Several mining experts in Canada have been appointed to serve on a committee under the chairmanship of Mr. R. A. Bryce, President of the Canadian Institute of Mining and Metallurgy, to investigate the possibilities of increasing the Dominion's output of zinc, copper, and lead. Meanwhile the Department of Mines is redoubling its effort to open up new sources of vital war minerals. Among the minerals sought for are scheelite, manganese ores, mica, fluorspar, and cobalt ores.

Robbing Peter, Cheating Paul.—More than one British infantryman was killed in Gallipoli in 1915, but, says Mr. J. H. Van Deventer, in *Iron Age*, without doubt the greatest loss of all was the death of Henry Moseley, the twentieth century's most promising physicist, whose technical genius could have been put to more profitable use for the Allies than facing the business end of a gun. Evidently we have not learned much since then. Over the past few months, three metallurgists and one expert in pyrometry have been taken from the Frankford Arsenal and put into combat service. Even key aviation designers have been drafted into the Army. Such shortsightedness is dangerous. For the present war, even more than the last, is a battle between laboratory and laboratory, as well as a battle between soldier and soldier. It did not take long for the war production heads to realise the necessity for priorities and allocations of essential materials. Why not the same with essential, and too scarce, trained man power? To put into combat service men of eight to ten years of technical training and experience is robbing industry of its ability to produce, and cheating our armed Forces of the means to strike—and strike hard.

Personal and Business

Sir Louis Sterling has been elected President of the British Institution of Radio Engineers.

Mr. J. S. Wills has been appointed a director of the Yorkshire Electric Power Company.

Mr. A. E. Cook has been appointed managing director of Craven's Railway Carriage and Wagon Company, Ltd.

Mr. W. H. Purdie has been appointed a director of William Doxford and Sons, Ltd., in succession to the late Mr. K. O. Keller.

We note with regret the death, on July 29th, of Mr. Edward Herbert Shaughnessy, M.I.E.E., late Chief Radio Engineer and Assistant Engineer-in-Chief of the G.P.O.

Mr. W. Westwood, General Secretary of the Ship Constructors' and Shipwrights' Association, has been appointed Chief Industrial Adviser to the Board of Admiralty.

Owing to the requisitioning, by the Government, of his London office, Mr. M. Du Plat Taylor, M. Inst. C.E., consulting engineer, is temporarily carrying on his practice at 6, Branstone Road, Kew, Surrey (telephone number Richmond 0900), till further notice.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the time and place at which the meeting is to be held should be clearly stated.

Institution of Automobile Engineers

Wednesday, Aug. 19th.—Luton Centre: George Hotel, Luton. General meeting. 6.30 p.m.

Tuesday, Sept. 1st.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Supercharging the Compression-Ignition Engine," C. B. Dicksee. 6 p.m.

Institution of Electrical Engineers

Saturday, Sept. 5th.—London Students: Visit to works of the Fuller Electrical and Manufacturing Company, Ltd. 1.30 p.m.

Institution of Production Engineers

Wednesday, Aug. 19th.—Birmingham Section: James Watt Memorial Institute, Great Charles Street, Birmingham. "Production Control: Its Meaning and Function," R. Appleby. 7 p.m.

Men of Maudslays

Friday, Aug. 21st.—Visit to the works of Mr. E. G. Izod. Full particulars will be notified to members.